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INFANTRY FIRE TACTICS.

BY

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ROYAL ENGINEERS.

"FIRE IS EVERYTHING, THE REST IS OF SMALL ACCOUNT."—

Napoleon I.

SECOND EDITION.

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PREFACE.

The following work is the result of some years constant, though pleasant and interesting work, and my labours will be far more than repaid if, in any way, they are productive of good to the British Service.

The size of the book shows the development that the subject of Infantry Fire Tactics has reached, and in the following pages the reader will see that *superiority of fire is to be obtained more by a rational and good tactical use of the rifle than by any actual superiority of armament*, though this latter consideration must be given its full weight. Other things being equal, the better the rifle, and its ammunition, the greater will be the effects of the fire.

The following pages will show the kind of data and statistics that should be found out for any new rifle, by experiments, in order to work out rules for the Fire Tactics to be used with it. But though, in the following pages, rules of firing have been deduced, based on the total height of an average man, yet it would appear to be preferable to use only the height of an average man's shoulder for this purpose.

I have endeavoured my best to place the arguments on both sides of any debateable matter as fairly as possible, and I must ask the reader to pay as much attention to the footnotes throughout the book, as to the matter to which they refer.

The only mathematics used in this book, are simple addition, subtraction, multiplication and division, except in one part only of the book, in dealing with "Indirect Fire." In this case, a slight knowledge of trigonometry is also required.

A study of the following pages will well illustrate the old adage, that "a more perfect tool requires a more skilful workman," and we must never forget that under the rude test of war, if we wish to obtain even a small result in the field, it is necessary to demand much in peace. It is the inherent impressionable character of the nature of man, that may, and often has, upset the most matured plans and resolutions. One of the great objects of military training, is to so strengthen a man's natural moral qualities by the iron bands of discipline, and by the groove that custom and habit induce them to move in involuntarily, that they may become more of a fixed quantity under all circumstances, than a fluctuating one.

This object can only be attained by constant training and practice in what should be done in the field, and this is all the more necessary, because knowledge, and the application of that knowledge, are two totally different things. Knowledge is comparatively easy to attain; the application of it is hard. The former has first to be gained by study; the latter, which is the real key-note of success in war, can then only be learnt by constant practice. We have not nearly enough target practice in our army, by which alone accuracy of fire can be obtained. Accurate firing, or quality of firing, is of more importance than the mere quantity of it.

With regard to the general conclusions arrived at in the following pages, it will be found that *fire at short ranges should be the general rule in order to obtain decisive results, and that long-range fire should only be made use of under conditions favourable to its efficacious employment: while, at all ranges, the most stringent control over the fire should be maintained.*

My great difficulty has been a want of English statistics, and I have had, in consequence, to gather my information from a considerable number of foreign works, which have not in many cases agreed with one another, and as the following pages have been written only in the spare time that I could find amidst considerable professional work, I am afraid that some errors and mistakes may have crept into them. For these, I must offer an apology to the reader, and I should be very much obliged if any one would kindly do me the favour of pointing out such errors to me, or any parts of the book which may appear ambiguous.

My best thanks are due to Major MacClintock, R.A., who has given me much information on various points, and I have also to thank Major E. Nash, R.A., and many other officers, especially foreign ones, who have been good enough to give me their views and criticisms on various points, and who have sent me much fresh and useful information, nearly all of which has been embodied in the following pages.

The following list gives most of the works that have been consulted in my studies, and, in many cases, complete extracts have been taken from them, but as these extracts were at first made in the form of manuscript notes for private use, without reference to the authority, apologies are here made for any non-recognition, in the body of the work, of the authority of the extracts, or of which portions are extracts.

C. B. Mayne,
Capt., R.E.

Royal Military College,
Kingston,
Canada.

August, 1888.

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Note on a Short Base Range-finder, by A. MALLOCK, 1886.

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NOTICE ON THE SECOND EDITION.

On account of the very favourable manner in which the First Edition of this book has been received, there has been a considerable revision and re-grouping of matter in the Second Edition, with a large amount of fresh information added. By these alterations it is hoped that the value of the work, whatever it may be, has been greatly increased.

The most important additions are to be found in Chapter X., showing how the effects of fire have been ascertained on the Continent. It is most important that similar experiments should be carried out for our new rifle, both at home and in India, for the effects of fire stated in this work are not the same for all rifles. The few pages on "Musketry Fire Tactics," to be found in our Infantry Drill Book of 1884, are a deliberate and unacknowledged translation from the French Musketry Regulations—so much so that, where the French have laid down the outer limit of long-range fire as the range for the extreme graduation of their backsight, 1,600 mètres, or 1,700 yards nearly, the same limit has been inserted in our Drill Book, although our backsight is only graduated up to 1,400 yards! And all these French statistics for the Gras rifle, after having been dressed up in English units of measure, are headed *Limits for the Employment of Fire with the Martini-Henry Rifle!* Is it a proud position for a country like England to coolly copy the work of other nations like this? To always follow is to always remain behind.

Chapter XV., on Fire Discipline, and Chapters VII. and XIX. on Rapidity of Firing and Magazine Rifles, have also received special revision and additions. Chapter XIII. on Ammunition Supply has been in large part altered to bring it up to date with the latest published regulations on the subject.

With regard to the fire of magazine rifles, the writer has made some experiments as to whether such rifles do or do not entail an increased expenditure of ammunition. In these experiments the target was made to appear at intervals for a short time, and during these intervals of exposure a rapid aimed fire was kept up, using the magazine each time. The result was that nearly double the amount of ammunition was expended, with nearly double the number of hits. The ranges were known. The rifle used was a Winchester magazine rifle, used as a single-loader and as a magazine rifle.

In Appendix I. will be found some new and interesting information concerning the effect of atmospheric conditions on the flight of bullets. It will be seen that the effect may often be considerable, and it seems very necessary that officers should know what these effects are, and in what way to allow for effects of temperature and wind especially. The effect of atmospheric pressure is fairly constant over a large tract of country, and so does not require the constant attention of officers, like the temperature and wind do.

One kindly critic, Colonel Mackinnon, of the School of Musketry at Hythe, has objected to the title of the present work, saying that Infantry "Fire" Tactics cannot exist separately or apart from Infantry Tactics generally. The Author fully coincides with Colonel Mackinnon's views, but custom permits of the individualising or separation of Tactics into various sub-branches, and it is to the sub-branch of the efficient use of the rifle in the field that the present work is devoted. In foreign military literature we constantly meet with the terms "tactics of marching," "tactics of fighting," "tactics of mobilisation," "tactics of supply," "tactics of fortification," &c., &c.; the word "tactics" meaning the *execution*, or rather methods of execution, adopted to carry out the *conception*, which is the true province of strategy. It is with this meaning of Tactics that the Author has adopted the present title of the book.

C. B. M.

NOTE.—Just as this book was being finally printed, the Author received a copy of the new official pamphlet, "*Infantry Tactics as Influenced by Fire*," which is evidently intended to re-place the few pages on "*Musketry Fire Tactics*" in the Field Exercises of 1884. Much of this pamphlet has been bodily taken from this book, and in it, the sub-division of ranges, recommended on page 266, has been practically adopted.

The new German Ammunition Supply Regulations have been very inadequately embodied in this work, because, up to the time of going to press, the Author has not been able to obtain any good account of them.

PART I.

CHAPTER I.

INTRODUCTION.

In the next war, the nation which has best educated its troops to the true character of modern fighting, by teaching them to do in peace what they will have to do in war, and by subordinating to that end the whole training of the soldier, will have placed itself in a position to have gone, at least, a long way on the road to gain success.

Now-a-days the instruction of the individual soldier is all important, for he must be imbued with the spirit of modern fighting, feel thoroughly at home in the various phases of the fight, know what is required of him in them, and be able in all circumstances to make the best use of his weapon.

Improved weapons have increased the range at which fire may be opened, and the deadliness of fire at all distances but especially at the short ones, and the consequence of this has been to replace the shock tactics of closed bodies by the fire of extended ones, as the ruling principle in battle. This naturally requires more individual action on the part of the soldier; but as this *apparently* has a tendency to do away with the authority of the leaders, it raised at first a great cry against it, as being subversive of discipline and contrary to the principles of being able to keep men in hand, available for the ever varying requirements of a fight. Experience has, however, shewn that this greater individual action for the soldier is a necessity, and hence the problem to be solved is, how the consequent unavoidable loosening may be best minimised and adapted to attain the end in view; a rigid training to true principles is now recognised as the only way of doing this, and to so habituate the men in peace time to what they will have to do in war, as to cause it to become a second nature to them.

After a hard struggle the bullet has gained a complete superiority over the bayonet, but *it is only in the proper*

use of the rifle, as regards fire, that this superiority has been won. However, a use for the bayonet still exists in its proper place; the final appeal has still to be made with it in action, to show the demoralized defenders how hopeless is their case by proving to them the power the attacking troops still possess of advancing; besides which, it gives a moral and material support to troops at night, on sentry duty, &c.; but henceforth it is to fire, and not to the final hand-to-hand conflict, that the true decision of the fight must be looked; the bullet must render the bayonet attack feasible and possible. The late actions in the Soudan afford examples of this fact in the highest degree. Our troops there had to withstand the most desperate assaults conceivable, which they annihilated by fire alone. While we relied on our fire our losses were few, and they only really began to occur when we had to give it up to use the bayonet instead.

"Formerly fire-arms were used to induce such a state of things as would make it possible to bring the bayonet to bear. The fact of a bayonet charge taking place, then, implied that the critical moment had come. Now the rush to seize a position implies that the critical moment *has passed*, or the rush is sure to be fruitless."—(*Wellington Prize Essay* 1872, p. 86).

The English Musketry Regulations of 1877 said that: "The rifle is placed in the soldier's hand for the destruction of his enemy: his own safety depends upon his efficient use of it: it cannot, therefore, be too strongly inculcated, that every man who has no defect in his eyesight may be made a good shot, and that no degree of perfection he may have attained in the other parts of his drill, can, upon service, remedy any want of proficiency in this; in fact all his other instruction in marching and manœuvring can do no more than place him in the best possible situation for using his rifle with effect."

All this is perfectly true and greatly to the point, except the sentence that every man with good eyesight can be made a "good" shot or even a "fairly good" shot, as the Musketry Regulations of 1887 say. The whole of our old system of musketry was based on this statement, and the individual fire of a single man was accordingly raised to the highest place. The falseness of this hypothesis, and the practice consequent on it, was amply proved in our late campaigns, where our shooting is reported to have been as bad as it could possibly be. The fact of the matter is that only very

few men are individually good shots, especially when under fire, and those that are such, have their skill nullified in the field by the excitement of the fight and by not knowing the ranges exactly—the almost all-important point for accurate shooting. This fact will be clearly seen in the following pages, and how it can, to some extent, be remedied.

How then is firing to be carried on in the field if individual shooting is of no avail generally? The modern solution to the question is found in the controlled collective aimed fire of masses for all but the shortest ranges, at which unaimed individual fire alone is possible from the impossibility of controlling the excited mass of men; and, as it is only at these shortest ranges, that such individual fire has any efficiency in the field, its use at these distances is allowable.

The subject matter in the following pages is divided into three main parts.

I. Individual fire and its applicability to short ranges only; appreciation of distances.

II. Collective fire for long ranges; influence of ground on fire; long and short range fire; supply of ammunition; controlled and uncontrolled fire; fire discipline, control and direction.

III. Tactical deductions; musketry instruction; the spade in warfare; repeating rifles.

Experiments made at home and abroad have shewn that the Martini-Henry rifle, except as regards accuracy of fire, is practically not a bit better than the best of the other military rifles on the Continent, viz.: the German Mauser, the French Gras, and the Russian Berdan. Up to 500 yards, all these Continental rifles have a flatter trajectory than ours from having a lighter bullet and a greater muzzle velocity, but over 500 yards, *i.e.* at the least important ranges, our rifle has the advantage in flatness of trajectory, from its having a heavier bullet, which suffers less retardation than the lighter ones used on the Continent.

In this work it is hoped that the true basis will be clearly pointed out on which musketry instruction and the manner of using rifle fire in tactical operations should rest. It cannot be too strongly urged that *the requirements of a battle should govern the use and practice of infantry fire*, and it is essential that this should be the controlling element of any musketry regulations which are intended to be of use in the field.

It is necessary above everything not to lose sight of the

fact, that the question of rifle fire has two sides—(1) a wrong, and (2) a right one:—

(1) A defective employment of rapid loading weapons leads to an abuse of rifle fire, a waste of ammunition, and compromises and even destroys discipline for fighting, while

(2) On the other hand a rational use of the same weapons procures the most powerful means of fighting an adversary, and hence it should be our aim to try and obtain this second condition of things.

It may be said that success in war has never been more intimately connected with the employment of fire than now-a-days, and consequently the conduct of fire on the battle-field calls, more than ever, for a complete and practical preparation for it. The Author hopes in the following pages to offer, according to the light of present experience, a practical solution to this question, for which, however, he cannot claim any originality.*

"On the Continent the Germans have, since 1877, entirely transformed everything connected, either directly or indirectly, with infantry fire; but they have especially made important modifications in the conduct of the fire on the field of battle, because they have instituted the substitution of the regulated, sudden and intermittent fire of masses for the old continuous and interminable musketry fire of infantry. The German theories, while still upholding the importance of having good marksmen in collective firing, yet especially bring out the fact that good results can be obtained with even average men, under the condition that these men are kept in hand by means of a certain control and by a particular fire discipline, obtained by the aid of a special method of instruction.

"The requirements imposed on an officer, in order to carry out judiciously the direction of the fire, are not great, because this direction consists only of the putting into practice of some very simple rules. The necessary ideas for the rational conduct of fire in varied ground can even be acquired by means of a very practical method of training, appealing especially to the sight, and only requiring the most elementary theoretical knowledge. All these proceedings are simple enough to be applicable on the battle field: at the most, they only require, in order to be put into practice, a knowledge of

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* A paper on a part of the subject of this work, entitled "The Utilization of Rifle fire in the Field," appeared in the *Journal of the Royal United Service Institution*, vol. xxvii. It has been gathered from the same source as much of the matter in the following pages.

the range to within 12 or 13 yards in every 100 yards of the estimated distance, as well as an idea of the direction in which the inclination of the surface of reception falls with respect to the line of sight prolonged, without its being necessary to be more exactly informed as to the value of this inclination.

"The German regulations on the use of fire in war are drawn up on the hypothesis of troops acting in the open field. This remark is not useless, because the conduct of the fire of infantry is different according to whether this arm fights on a field of battle or takes part in the attack or defence of fortified places. Certain methods of procedure, to be condemned if an attempt is made to make use of them in the first case, would give, on the contrary, very good results in fortress warfare.

"Fire in war *(Les feux de guerre)* can be executed as an individual fire or as a collective fire.

"An individual fire is left, in a certain measure, to the initiative of the individual; it is executed by men freed in great part from any fire discipline; free, accordingly, to choose their object, their sight, and to regulate the consumption of their ammunition.

"A collective fire is the putting into play or the regulated and rapid, if not simultaneous, action of a variable number of rifles, in obedience to a common thought and to the will of a single man.

"Individual firing ought only to be employed, as a rule, at the nearest distances to the enemy, when it becomes impossible for a leader to exercise any control over the fire."

In studying the following pages, the reader is supposed to have a knowledge of the lectures given in the Musketry Regulations, and also of the Theory of Musketry, to be found in the Official Text Book on the subject entitled, "Treatise on Military Small Arms and Ammunition," by Lieut.-Col. H. Bond, R.A., which must therefore be referred to for technical matter and definitions.

Before proceeding, we must first define, with regard to their horizontal and vertical directions, the different kinds of fire which can be used.

Infantry fire, as regards its *horizontal direction or on plan*, is said to be:—

(1). Frontal, when it is so delivered as to strike perpendicularly the front of the object fired at.

(2). Oblique or Cross, when the object is struck in front, but not perpendicularly.

(3). Enfilade, when the direction of the fire is along the length of the object.

(4). Reverse, when the fire strikes the rear of the object.

The moral effects of oblique, enfilade and reverse fire are very much greater than those of a purely frontal fire, and therefore should always be used in preference when possible, but to do so necessitates the flank or rear of the enemy being gained; an oblique or cross fire can, however, in some cases be obtained by men firing rather towards one flank instead of to the front.

As regards material effect, the more oblique the fire is to the front the greater it is likely to be, as a greater depth of the object is struck or crossed by the fire, and hence enfilade fire has the greatest effect, independently of the moral effect it also has from being delivered against the direct flank of the enemy.

Infantry fire, as regards *its vertical direction*, or rather *its trajectory*, is said to be:—

(1). Horizontal, when the line of sight is horizontal.

(2). Inclined, when the line of sight is inclined to the horizontal.

(3). Direct, when the fire is directed on a seen object.

(4). Grazing, when the fire passes for some distance closer to the ground than the height of the object fired at. It is the opposite to the two following kinds of fire, which drop more or less perpendicularly.*

(5). Plunging, Searching, Curved or Dropping, when the fire is directed against an unseen object immediately behind a seen obstacle or cover, such as troops *close* behind an earthwork.

(6). Indirect, when the fire is directed against an unseen object some distance in rear of a seen obstacle which covers it, such as troops in a valley *some distance* behind a hill.

It is easily seen from the above that any kind of fire, as regards horizontal direction, can be combined with any kind of fire as regards trajectory. Thus a frontal fire may be horizontal, inclined, direct, plunging or indirect, and so on.

Whether the fire be horizontal or inclined, the *trajectory for any given range remains practically in a constant position with reference to the line of sight.* So that having drawn the trajectory of a given range for a horizontal line of sight, we have only to move the whole figure up or down to obtain the trajectory for any given amount of inclined fire. This statement is not of course mathematically correct, but it is sufficiently so for all practical purpose as regards the trajectories of rifle bullets, when the fire is not much inclined.

* As to when a grazing fire ceases and becomes a dropping one, see p. 193.

CHAPTER II.

THE POWER OF THE MARTINI-HENRY RIFLE.—RICOCHETS.

At target practice, men lying down, from being able to rest their elbows on the ground, fire more accurately than those kneeling; and those kneeling than those standing. Thus the lying-down position should be the normal position for firing, especially as the nearer the enemy is, the more destructive is his fire, if he is not demoralized, and the more necessary is it to lie down in order to form the smallest possible mark; this position has also other advantages besides that of allowing of more accurate shooting, viz.: that the smoke of the powder in dispersing begins from the lowest part, so that men lying down can see the enemy when men kneeling or standing up cannot distinguish anything through the smoke; the lying-down position further allows of the smallest folds of ground being utilized as cover.*

The following is an *approximate* trajectory table of the Martini-Henry rifle when it is held one foot above the ground, and aimed at the foot of the mark (see p. 67 *et seq.*). This, supposes the man firing to be lying down, in which attitude he would almost always be in action,—at long ranges to get a more steady aim, and at medium and short ranges to form a smaller mark. Hence, if aim is taken at the bottom of the target, the line of sight may be taken as coincident with the ground. The height of cavalry is taken as 8 feet, of infantry as 5½ feet. The distances are given to the nearest yard, and the heights to the nearest ¼ of a foot, so that they are only approximations; the ground is further supposed *to be parallel to the line of sight.* The data in this table are for a muzzle velocity of 1,320 feet per second, a fine day (*i e.*, barometer 30-ins. thermometer 62° F. and the weight of a cubic foot of air 534·22 grains) and when the force of gravity =32·1908, and hence *they would be different for other muzzle velocities, and other conditions of atmosphere and gravity.*

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* Of course there are cases in which a lying-down position would be useless, as in a flat country intersected with hedges, or when on ground covered with high grass, bushes, &c.

TABLE I.

1	2	3	4	5	6	7
Range in yards.	Angle of Elevation of Mean trajectory.			Greatest height of Mean trajectory in feet above line of sight. (1)	Distance in yards of greatest height of mean trajectory from origin of fire. (1)	Angle of drop of Mean trajectory.
	Angle. (2)	1 in.	Tangent.			1 in.
	° ′					
0	..	..	..	..	..	..
100	0 10	381·67	·0029	0·05	52	304·00
200	0 21	163·31	·0061	1·00	105	128·00
300	0 34	101·11	·0099	2·75	160	78·20
400	0 49	70·17	·0142	5·00	216	55·40
500	1 9	49·82	·0201	8·50	273	41·90
600	1 27	39·51	·0253	13·25	331	33·00
700	1 46	32·42	·0308	19·00	387	26·10
800	2 6	27·27	·0367	26·25	446	21·20
900	2 28	23·21	·0431	35·25	507	17·60
1000	2 50	20·20	·0495	45·75	566	14·70
1100	3 14	17·70	·0565	57·43	623	12·50
1200	3 40	15·60	·0641	73·50	690	10·60
1300	4 8	13·83	·0723	90·50	752	9·13
1400	4 40	12·25	·0816	109·92	812	7·87
1500	5 15	10·88	·0919	..	..	6·82
1600	5 54	9·68	·1033	..	..	5·94
1700	6 37	8·62	·1160	..	..	5·20
1800	7 24	7·70	·1299	..	..	4·57
1900	8 14	6·91	·1447	..	..	4·03
2000	9 7	6·23	·1605	..	..	3·56
2100	10 3	5·64	·1772	..	..	3·12
2200	11 3	5·12	·1953	..	..	2·75
2300	12 7	4·66	·2147	..	..	2·43
2400	13 17	4·24	·2361	..	..	2·15
2500	14 25	3·89	·2571	..	..	1·89
2600	15 53	3·51	·2845	..	..	1·68
2700	17 28	3·18	·3146	..	..	1·50
2800	19 18	2·86	·3502	..	..	1·30
2900	21 10	2·58	·3872	..	..	1·13
3000	23 20	2·32	·4313	..	..	0·94

(1) These numbers suppose the line of sight coincident with the ground.
(2) These are given to the nearest minute of arc.

TABLE I—*continued.*

8	9	10	11	12	13	14	15
Range in yards.	Theoretical dangerous space of mean trajectory in yds. (1)		Time of flight in seconds, over whole range. (1)	Striking velocity in feet per second. (1)	Drift of bullet in feet. (1)	Maximum vertical error in feet.	Maximum horizontal error in feet.
	Cavalry, 8 feet. (2)	Infantry, 5½ feet. (2)					
0	..	..	..	1320	..	..	..
100	Throughout	Throughout	0·24	1171	0·3	0·23	0·23
200	do.	do.	0·51	1051	0·8	0·40	0·35
300	do.	do.	0·81	982	1·5	0·69	0·58
400	do.	do.	1·12	927	2·3	1·08	0·86
500	163	92	1·46	880	3·3	1·33	1·07
600	92	63	1·80	838	4·5	1·68	1·38
700	70	48	2·15	805	5·8	2·10	1·68
800	56	39	2·51	773	7·3	2·58	1·98
900	47	32	2·88	741	9·0	3·16	2·35
1000	39	27	3·32	711	10·8	3·85	2·78
1100	33	23	3·76	681		4·68	3·20
1200	28	19	4·23	657		..	..
1300	24	17	4.68	635		..	..
1400	21	14	5·15	614		..	..
1500	18	12	5·65	595	(see Footnote, p. 29.)	..	..
1600	16	11	6·19	576		..	..
1700	14	9·5	6·75	560		..	..
1800	12	8·5	7·31	545		..	..
1900	11	7·5	7·89	530		..	..
2000	9	6·5	8·50	517		..	..
2100	8	5·5	9·13	505		..	..
2200	7	5	9·93	495		..	..
2300	6	4·5	10·77	487		..	..
2400	5·5	4	11·64	482		..	..
2500	5	3·5	12·56	479		..	..
2600	4·5	3	13·71	475		..	..
2700	4	2·7	14·94	476		..	..
2800	3·5	2·4	16·26	479		..	..
2900	3	2	17·65	486		..	..
3000	2·5	1·7	19·31	504		..	..

(1) These numbers suppose the line of sight coincident with the ground.
(2) See formula on p. 15.

The *first catch* is that point in the trajectory where the bullet has descended sufficiently low to strike the heads of cavalry or infantry respectively, that is to bring them under the power of the rifle.

The *dangerous space* (also called the *dangerous zone*) shows the space in yards within which the object fired at is under the power of the rifle, and is the dangerous part of the trajectory, or the space in which the bullet is dangerous, or can do its intended work. It begins at the first catch and theoretically ends at the *first graze*, which is the point where the bullet if not interfered with will first strike the ground; but, practically, it extends further than that point, as the bullet does not stop there, but glances or rebounds or *ricochets* off the ground, and continues its progress for some distance, though generally in a new direction, but still capable of doing damage.

The greater the space over which the bullet is dangerous, that is, the greater the dangerous zone, the more efficient must be the fire, and from the table we see that *for an individual fire, as the range increases the dangerous zone decreases.* Thus, *the efficacy of fire increases as the range gets shorter*. The truth of this will be much more apparent as we proceed, for there are other causes which intensify it.

The *greatest height of trajectory* (or the *culminating point* as it is called), is the greatest height the bullet rises above the line of sight during its flight. The distance of this point from the rifle, or origin of fire, increases with the range, being at about $\frac{1}{2}$ to $\frac{2}{3}$ of the whole distance,—the longer the range the larger the proportion.

The actual *angle of elevation* itself, in degrees, &c. for certain chosen ranges, is not marked on the backsight of the rifle, but only the range is engraved for which the particular elevation is suitable. It is very important to remember that *we must know the distance an object is from us before we can tell what elevation to give to the axis of the barrel, by means of the backsight, so as to hit the object*. The graduations on the backsight are found by experiment.

The *angle of drop* is a most important point to consider, as the first catch and dangerous zone are governed both by it and by the height of the object fired at. As the dangerous zone is the space in which a bullet is dangerous, this consideration is the one which really decides the power or efficacy of a rifle, especially at the shorter ranges.

The *time of flight* to any point of the trajectory is the time that the projectile takes to go from the origin of fire to this point. It can be obtained either experimentally or by calculation with Bashforth's tables.

On this time of flight depends the curvature of the trajectory, because the greater the time of flight, the longer the period during which gravity can act.

By taking the differences between the times of flight for successive ranges, we see that the time required to pass over a given distance, such as 200 yards, increases as the bullet gets further away. It only takes 0·51 seconds to pass from 0 to 200 yards, whilst it takes 3·05 seconds to pass from 2,800 yards to 3,000 yards. This is due to the resistance of the air which is continually decreasing the velocity of translation of the bullet. A bullet reaches its highest point in half the time of flight, and hence it is evident that this highest point is always beyond the centre of the range.

The time of flight of a projectile is practically utilized when a moving object is being aimed at, by aiming a certain distance ahead of the moving object, in the direction of its movement, which distance depends on the range and the velocity with which the object is moving (see p. 25).

We know, from both experience and calculation, that different bullets as regards weight, form, and sectional area, rise to different heights in going over the same range. This brings us to consider the "flatness of a trajectory."

The *flatness of a trajectory* is measured by the ratio of the greatest height of the trajectory above the line of sight to the corresponding range, and the smaller this ratio, the more the trajectory is said to be "flattened."

The five qualities of a military rifle, in order of relative importance, are as follows: the 1st, 2nd, 3rd and 5th, being known as the *ballistic* qualities of the rifle, and form a guide as to what can be expected from it in the field.

1. Long Range; but the range alone is not sufficient to give an exact measure of the ballistic value of the arm, and hence
2. Flatness of Trajectory must be considered as well. It should be as flat as possible to make a low trajectory, and therefore to increase the dangerous space, and thus to diminish the effect of any errors made in the estimation of the distance.
3. Accuracy of Fire is the greater or less probability of striking the object aimed at. We shall deal with this

more at length later on, when we shall see why the quality of accuracy is placed third on the list; but with equally flat trajectories, the more accurate the weapon the greater value it has in war.

4. Rapidity of Fire, or the number of shots which can be fired in a given time, governs the *intensity* of the fire, and, as we shall see further on, may make a moderately accurate fire more effective and terrible than a more accurate but slower one. The rapidity of fire *permissible* is, however, governed to a great extent by the facility of loading and by the amount of ammunition available; as we shall see later on, the greatest *possible* rapidity of fire is never required.

5. Penetration,* or the power of damaging the object when struck. If the projectile fails in penetrative power all the above qualities are useless. But as all the present military rifles possess this quality sufficiently for all practical purposes, it will not be dealt with again.

For a given range the trajectory is flatter, as the ordinates and the angles of elevation and descent are smaller. Flatness of trajectory is perhaps the principal quality of an arm for war, for on it depends the dangerous zones as well as the power of ricochets.

The advantages of a flat trajectory may be summed up chiefly under three heads, viz.:—

(1) Greater accuracy.
(2) Harder hitting.
(3) Greater efficiency in covering the ground.

(1) Greater accuracy; since the direction of the bullet on striking is less oblique to the target with the flatter trajectory, and consequently small errors in aiming or in judging distance are of lesser importance.

(2) Harder hitting; because, the velocity being higher, if the bullets are the same weight and fired out of similar rifles, the blow must be harder and the penetration greater.

(3) Greater efficiency in covering the ground; because for the same range, the bullet does not rise so high in the air.

Hence, what is most required in a military rifle is *as flat a trajectory as possible* at all ranges, but especially for tactical and

* The penetration of a bullet depends on its striking energy and rotation, and on the form and material of both the bullet and the object struck.

other reasons, at the shorter ones, *with the greatest accuracy of fire attainable.* Where ranges are accurately known, as at measured butts, it is usual in rifles for prize shooting to try and gain accuracy alone. In war, ranges are not known anything like accurately, and therefore flatness of trajectory is most important to reduce the effect of errors of estimation of distances. The effects of flatness of trajectory and accuracy must be considered together. In some French experiments it was found that the Winchester rifle was more accurate than the French rifle, but it has a much higher trajectory, and is not therefore so well adapted for military purposes. Thus accuracy of fire does not entail or even improve flatness of trajectory, but for the same rifle a flatter trajectory as a rule improves the accuracy, which latter quality mainly depends on the perfection of manufacture of the rifle and its ammunition, and on the obliqueness with which the bullet strikes the target; while flatness of trajectory almost entirely depends on the muzzle velocity and sectional density* of the bullet.

Very accurate weapons with high trajectories are all very well with skilful and cool men, who know their distances exactly; but great accuracy of fire cannot at any time be readily utilized by the mass of men, especially when excited under fire and unsteady from rapid movement. The errors of a good shot firing without a rest are double those made when firing from a rest; for an average shot they vary from three to four times more; while those of a bad shot, who fires hurriedly and without aiming, are incalculable. But flatness of trajectory can be utilized immediately by every man, both good and bad, as it is independent of the man, and thus a flat trajectory increases the value of a rifle for military purposes.

Hence we should principally aim at progress in flattening the trajectory of the arm more than in increasing its accuracy.

We must always remember, however, that *rifles are weapons whose value only depends on the skill of those using them.*

Ricochets.

As a rule in experiments against targets we do not deal with the effect of "ricochets" (as ricocheting bullets are called), but to do so in the field is to detract, to a very important

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* For definition see official Treatise on Military Small Arms and Ammunition.

extent, from the full value of our fire. The following remarks on the value of ricochets have been extracted from the report of the Siege Operations Committee on the fire of the Martini-Henry rifle.

If the angle of drop is not too great, and the nature of the ground suitable, a bullet on striking the ground will glance or ricochet off it, and go on, but on account of the right-handed twist or rotation of the bullet, given by the rifling of the barrel, the bullet usually deflects to the right after touching the ground. Experiments have shown that the mean rise of the ricochets, after touching the ground, is about twice the drop, but it is very variable, and the mean deflection to the right is about 1 in 100, the maximum being 2 in 100, so that it may be taken as almost continuing in the plane of the trajectory.

The practical limit in range on level ground at which ricochets can occur is about 2,000 yards, where the drop is 1 in 3·56, but it depends greatly on the nature and slope of the surface on which the bullets fall. Ricochets have been obtained up to 2,700 yards in some cases, and in which the bullet continued for 100 yards from there. Bullets on striking at 1,400 yards ricochet for about 300 yards and show a great deal of striking energy. Bullets fired at short ranges on level ground will ricochet several times, and some of them go to considerable distances. Up to 1,500 yards the mean length of the first ricochet is about 280 yards, which remains pretty constant with the range, because, though as the range increases up to 1,500 yards, the bullets rise with less velocity, yet they rise at proportionately greater angles (as the angle of drop is greater), and this causes a somewhat uniform distance to be maintained. Beyond 1,500 yards the length of the first ricochet decreases, because the relative proportion between the velocity and angle of rise diminishes.

A slight consideration will show that a fire which meets the ground at a small angle is favourable for ricochet, while a dropping fire is not.

From Table I., on page 9, we see that the striking velocity of a bullet is least at 2,600 yards, and that it increases after that. The reason of this is that the effect of the attraction of the earth on the bullet, which is making it to drop more and more vertically and rapidly every moment, is greater than the effect of the resistance of the air. Now the penetration at 2,600 yards will disable men, and therefore it will do so at longer ranges as well. Thus at the extreme

range of the rifle the bullet still retains sufficient striking energy to cause effective ricochets on reverse slopes with suitable fall.

The penetration of the ricochets of the Martini-Henry bullets has been found to be remarkable, even at the long ranges of 2,500 and 2,800 yards, for some of them passed through a $\frac{3}{4}$-inch spruce board.

All this shows that the bulk of ricochets are effective, and the Siege Operations Committee found that, on the targets fired at, one-fifth of the hits were ricochets, a very important proportion. Taking only the rising part of their flight after impact, the whole dangerous zone of musketry fire at any given range on a favourable surface may, as far as ricochets occur, be considered as one-half greater than the direct dangerous zone alone, exclusive of any effect due to the subsequent drop.

For the effect of the slope and nature of ground on ricochets see pages 205, 206.

NOTE.—(See page 9). *Approximate formula for the theoretical dangerous space of the mean trajectory for infantry (6 feet high), for ranges over 400 yards.*

Dangerous space in yards for infantry, 6 feet high,

$$= \frac{56{,}000}{\text{Range}} + \frac{\text{Range}}{200} - 31$$

where the range is expressed in yards.

The dangerous space for cavalry (8 feet high) for ranges of 500 yards and over, are about one-third greater than those for infantry.

CHAPTER III.

INDIVIDUAL FIRE.—ITS INACCURACY.

By *individual fire* is meant an independent fire, in which each rifle is directed on a different object, the range and elevation being either judged by the soldier himself or given him personally by his leaders.

Experiment shows, and theory, as we shall see, confirms it, that, however good a shot a man may be, his bullets will never strike on the same spot, even when the same point is aimed at each time with the same elevation, but they will fall over a considerable *surface** whose length in the direction of the fire is much greater than the breadth at right angles to it. This can only be due to involuntary "errors" being made both in elevation and direction at the instant of firing; and from the elongated surface over which the bullets strike, we conclude that, in shooting, any errors made in elevation tell more than the same errors made sideways or in direction. These errors arise from a variety of causes to be now explained, and they show more and more as the number of men firing increases, because it is quite improbable that each man will bring his rifle to the shoulder, aim, and pull the trigger in the same way, or have adjusted his backsight to exactly the same height by such insensitive means (though the only ones possible in the field), as his forefinger and thumb, or to have used the same amount of foresight in aiming, as the others.

The causes of irregularity, or of errors, in the firing of a rifle, may be classified under seven different headings, some of which apply both to firing in the field and at targets on measured ranges, and others only to the latter case. The causes of error are as follows:—

1. Those due to an imperfect determination of the exact range.
2. Those due to imperfections in the soldier.
3. Those due to imperfections in the rifle.
4. Those due to imperfections in the ammunition.
5. Those due to changes in atmospheric conditions.
6. Those due the method of executing the fire.
7. Those due to the duration of the fire.

* The word *surface* is used in preference to *area* as conveying more to the unmathematical mind.

Most of these causes may be further sub-divided into *constant* and *variable* causes. The constant causes of error deflect the fire without necessarily altering the accuracy of it, that is, they will produce a "concentration" or "good grouping" of hits, but away from the point aimed at, and they only require the soldier to make suitable corrections in aiming to place his shots around the point to be hit. The variable causes of error are those which vary with each shot and produce a "dispersion" or "bad grouping" of hits; they are as a rule due to the bad or irregular manufacture or preservation of the ammunition, to want of the skill in the firer, to adverse and inconstant atmospheric conditions (such as gusts of wind, great cold which numbs the soldier, cloudy weather, an obscure or badly lit up mark, etc., which render accurate aiming impossible), and to other accidental or temporary causes such as a heated barrel which burns the hands, the trembling caused by fatigue or long continuous firing, etc. However, to thoroughly understand what we are dealing with, it is necessary to enter more fully on these points as we shall now do.

1. Effect on the Shooting of Not Knowing the Ranges Exactly.

For accurate shooting at all distances, the range must be accurately known; this is an impossible condition in the field, for it can only be approximately ascertained, even with the aid of instruments called *range-finders*, which under the most favorable circumstances and with trained men, are only able to read to a percentage of the truth.

To hit an object, almost everything depends on the range being known exactly, in order that the proper elevation may be given to the rifle. Further on we shall see that this statement, under certain conditions, can be modified for short ranges. But at longer distances the very best shot cannot hit the object he aims at, if he does not know the range, while the very worst shot may do so if he does know it.

The knowledge of the range being so very important, it is highly incumbent on us to have the means of ascertaining it, either by judging the distance by the eye, by the use of range-finders, or from any artillery in position near at hand, for artillery can easily find the range by watching the burst of their shells when they strike the ground, or by any other means. It is said that the service pattern range-finder, called the "Watkin Range-finder," can find a range to within 2 p.c. of the truth with practised men, and under favourable conditions, but

as it is rather a complicated instrument to use, few men can work it with such accuracy, and in the field the conditions for a favorable use of it rarely occur. A simpler instrument, even if less accurate, is a great desideratum, especially as the requirements of the "Watkin Range-finder" hardly renders its use applicable for infantry under fire, even at medium ranges, though it may be so for artillery who fight at longer distances; besides which, most men find it hard to learn and easy to forget.

If we have no range-finder, or cannot get the range from the artillery, then we have to guess the distance, which is the very worst way of ascertaining it. In this case, the efficacy of the fire must be somewhat hap-hazard, and no exact, but only broad rules (which, besides other information, it is the object of this work to give), can be formed for making the chance of hitting the object fired at, a maximum. For a full description of the means of ascertaining ranges, we must refer the reader to Chapter VIII. on Range-finding.

2. Effect on the Shooting of Imperfections in the Soldier.

As rifles are weapons whose value only depends on the skill of those using them, the imperfections in the soldier are, perhaps, the greatest cause of error in shooting.

Two good shots, even when aiming at the same spot, with the same elevation, and with the same rifle, will make different shooting, because they hold the rifle to the shoulder differently, support it differently, see the backsight more or less clearly, use more or less of the foresight in aiming, pull off the trigger differently, &c.

A great deal depends on the eyesight and on being able to see clearly the sights and the objects aimed at. Any obscuration from smoke, haze, etc., or imperfect definition of the object aimed at, affects the aim. For accurate shooting the object fired at must be clearly seen; this condition is affected by the range, the size and colour of the object, the nature and colour of the background, and the firer's eyesight, &c., and in firing at men or horses at long ranges, one great difficulty of accurate shooting is that the apparent minuteness of the object fired at, as compared with the tip of the foresight, gives no definite point to aim at, and thus a man does not really know whether he is aiming a few feet too high or low, or to the right or to the left, and still less whether he is aiming at the centre of the object. Exact aiming at small

objects at long ranges is therefore impossible, and with an ordinary background (not a sky-line) cavalry cannot be distinguished from infantry by the eye alone over 1,400 yards. Thus at long ranges only large bodies of troops in close order formations, presenting a large mark, should be fired at; but now-a-days troops are not likely to expose themselves in such a way. As a rule in action all that men have to aim at is a bank or puff of smoke, which gives a very indefinite object, and the smoke arising from a large number of men, firing independently, is often so great as to completely prevent them seeing through it, while in any case it would greatly affect the aim and the accuracy of the fire, both by obscuring the view and by getting into the eyes and making them smart.*

As the range increases, a greater elevation of the backsight has to be used, which causes greater difficulty in aiming from the position of the firer being more strained, and from its being more difficult to know if the sights are upright. A backsight, graduated for more than 1,400 yards is of little value with the rifles and ammunition at present in use, as a man's neck is not long enough to use it.

The position of the eye with reference to the backsight, affects the amount of foresight used. A line of sight, taken on a target with the eye 2 or 3 inches from the backsight, will probably appear off the target if the head could be drawn back without moving the rifle. The firer must, therefore, get accustomed to always hold his head in one position so as always to ensure, as far as possible, using the same amount of foresight, but in different lights the same man will use different amounts of foresight, using more as the light is duller, because he cannot see the foresight so plainly. The effect of this is to give greater elevation and cause the bullet to go further than it should. On a finer day than usual the opposite occurs.

A man's eyesight and general steadiness are greatly affected by his state of health, and by what he has been eating and drinking. Hence, from this reason alone, a man's shooting will differ from day to day, even supposing that he uses the same rifle, and all other conditions are the same.

The backsight of the Martini-Henry rifle is graduated for use with a fine foresight. This is all very well for match firing, but in the excitement of action, when men are fatigued with marching, breathless with rapid moving, or when firing at objects which are only seen for a few moments, it is

* This is particularly the case with chemical powders, such as the E C. powder.

impossible, even if the men aim at all, to use a fine foresight, and hence a full foresight is invariably made use of, which causes the fire of the Martini-Henry rifle to go high. The height of the foresight is 0·12 inches and its distance from the backsight, when the latter is down, is 24·55 inches, and when the backsight is up, 26·50 inches; hence when the backsight is down the foresight subtends an angle of 16·80 minutes of arc, and when the backsight is up, an angle of 15·58 minutes of arc. Hence if we suppose an error of 15 minutes of elevation to be caused by the use of what is known as "a full foresight," we find that, at the different ranges given below, it would cause the bullet to strike the number of feet, given in the following table, higher than it should at the different distances stated from the muzzle of the rifle. These numbers only refer to the size of foresight given and the stated distance between the fore and back sights. For any other height of foresight or distance apart of the sights, the following table would not be correct.

TABLE II.

Range in Yards.	Approximate rise of the bullet in feet, due to using a full Foresight equivalent to 15 m. of arc, with the Martini-Henry rifle.							
	At 100 yds.	At 200 yds.	At 300 yds.	At 400 yds.	At 500 yds.	At 600 yds.	At 700 yds.	At 800 yds
100	1·47	—	—	—	—	—	—	-
200	1·34	2·87	—	—	—	—	—	—
300	1·23	2·61	4·12	—	—	—	—	—
400	1·00	2·07	3·27	4·55	—	—	—	—
500*	1·17	2·50	3·93	5·47	7·08	—	—	—
600	1·16	2·49	3·92	5·44	7·06	8·80	—	—
700	1·14	2·45	3·86	5·36	6·95	8·67	10·45	—
800	1·09	2·32	3·65	5·07	6·56	8·19	9·89	11·65

REMARK.—This table also shows the effect of using too much foresight with the Martini-Henry rifle. If one-tenth of the foresight was used, instead of a fine sight, the error would be about one-tenth of the above figures.—(See also Footnote on p. 23.)

* The reason why the figures in this table increase again after the 400 yards range, is because the position of the backsight with reference to the foresight has been altered.

The approximate alteration in range, due to using a full Foresight, equivalent to 15 m. of arc, with the Martini-Henry rifle is as follows :—	
100 yds. range increased to 225 yds.	600 yds. range increased to 680 yds.
200 ,, ..., 315 ,,	700 ,, ,, ... 775 ,,
300 ,, ... ,, 400 ,,	800 ,, ... 870 ,,
400 ,, ... ,, 490 ,,	900 ,, ... 965 ,,
500 ,, ,, .. ,, 585 ,,	1000 ,, ,, ,, ,,1060 ,,

From Table II. we see that in firing the Martini-Henry rifle with a full foresight, it makes a difference of about half the height of a man at 250 yards, and the whole height of a man at 450 yards, showing the necessity of graduating the backsight for a full foresight, such as the men would use in the field. *The use of a fine foresight is quite impracticable for war purposes.**

The Americans, who of all nations have perhaps paid most attention to the science of accurate individual shooting, say in their musketry regulations, "great care must be taken . . . that *the amount of front sight taken is the same as that usually seen by the soldier*," but as slight changes in this latter particular produce considerable effect on the target, consequently, "at the short and mid-ranges,† a halfsight "should generally be taken; at the longer ranges, "especially if the light is bad, it may be better to take "full sight." There is no mention here even of a fine sight for accurate target shooting, but as in the field, simplicity should be aimed at in all cases, it would be better to always use a full foresight and to train men to its use in peace time.

The difference in using a fine full foresight is like the difference in reading small and large print, this difference is more appreciably felt in movement or in the dusk. Similarly a full foresight is best appreciated under war circumstances. Further, even in peace time, the increased accuracy to be gained by using a fine sight can only be obtained by crack shots. Ordinary men will make as good shooting with a full

* If the backsight is graduated for a full foresight, a printed table might be issued for match shooting, giving the approximate elevations or different ranges for use with a full foresight.

† For division of ranges, see p. 266.

sight as with a fine one, and with far greater ease to themselves.

The backsight of all rifles is graduated on the supposition that it is kept upright, and for accurate individual firing it must be kept so. It is very hard for the firer to know that this is the case, especially at the longer ranges when the leaf-sight has to be used, and when it is most important for it to be upright, for even at target practice, under the most favourable circumstances, only a slight inclination of the backsight, to the right or left, will cause a 6 ft. by 8 ft. target to be altogether missed at 800 yards. The effect of such an inclination is to decrease the range and make the bullet go to the same side as the sights are inclined (see Lecture II., Musketry Regulations). It is especially hard to keep the sights upright when a wind gauge (see page 40) is being used.

Suppose the range to be exactly known, then for accurate shooting the sights must be accurately adjusted to the elevation for the range to within $\frac{1}{100}$th of an inch, because at 1,000 yards such an error causes the bullet to strike 14 inches* higher or lower on the target than it otherwise would, and, without a vernier scale it is impossible to know if the sights are adjusted to this fineness. An error of adjustment effected by the finger, and probably very roughly too under the excitement of an enemy's fire, will probably be as much as $\frac{1}{20}$th of an inch. Now, such a small difference as $\frac{1}{20}$th of an inch in adjusting the backsight is found to make a difference in height of $2\frac{1}{2}$ feet at 500 yards on a vertical target, and 6 feet at 1,000 yards, which shows the enormous effects of small errors at the longer ranges, and which are likely to be increased when we take into consideration the varying amount of foresight taken by different men. Anyone, who has shot in a match, firing at targets over known ranges, knows the importance of a vernier reading to at least $\frac{1}{200}$th of an inch for adjusting the backsight with.

The trigger *ought* to be pressed back in the plane of fire by putting the thumb on the top of the small of the butt, and pressing the trigger towards it with the fore or middle finger, in order not to disarrange the axis of the barrel at the instant of firing. However, even at target practice, few men do this,

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* At 500 yards, an error of elevation of $\frac{1}{100}$th of an inch with the Martini-Henry makes a difference of about 6 inches on a vertical target; at 600 yards, 7 inches; at 700 yards, $8\frac{1}{2}$ inches; at 800 yards, 10 inches; at 900 yards, 12 inches; and 1,000 yards, 14 inches.

while in action they would never *press* the trigger, as described above, in firing, but they almost always *pull* it with the forefinger, causing the muzzle to move slightly to the right, and throwing the bullet in that direction. The tendency for this displacement to the right is further unavoidably increased by the rifle being held to the right shoulder, and by its being supported by the left arm, which inclines to the right. For these reasons the French give a left-handed twist to the grooving of their rifles so that the consequent *drift** to the left may tend to counterbalance any error from the causes given above, which tend to throw the bullet to the right.

The soldier also very often flinches when he fires, by moving the shoulder to avoid the recoil, especially after a number of rounds have been fired. This is best prevented by so regulating the weight of the rifle, the bullet and the charge as to have a small recoil. The recoil of the Martini-Henry rifle is the heaviest of all the European military rifles, and it is undeniably too great. Few men can fire 70 rounds consecutively with our rifle fairly from the shoulder.† This tends to cause a deplorable waste of ammunition on the battle field by inducing men to fire without bringing the rifle to the shoulder, and therefore without aiming. The recoil also often painfully injures the finger by the trigger guard striking it, which further makes the soldier unsteady in his aim.

The fatigue of a soldier after marching, his unsteadiness after rapid movement or under any excitement, the coldness of the weather, the heat of the barrel, etc., all seriously affect his shooting. A full sight can be easier used by him in such cases than a fine sight.

All the above points, in addition to the firer's personal defects of eyesight, his unsteadiness under fire, his excited

* The resistance of the air, combined with the rotation of the bullet, causes the axis of the bullet to approach the trajectory, and its point to remain in advance throughout its flight, while it also produces a lateral motion of the entire projectile. This lateral deviation of the bullet receives the name of *drift*; its direction is determined by that of the rifling.

† The Author heard of a case of a recruit who fired with a Martini-Henry rifle, 60 rounds of ball ammunition in succession and had to go into hospital for some time afterwards. In a second action at Charasiab in Afghanistan, he also heard of an old soldier in a crack regiment, who was a very good shot, being given a box of ammunition to make the best use of; this man's shoulder after the action was described as a "jelly."

state of mind from the sound of the enemy's bullets, the firing, the cries of the wounded, and the sight of the dead, the difficulty he has in aiming with a high backsight or in a wind, his fear of the recoil after having fired several rounds from his shoulder beginning to get sore—a very important fact,—and the difficulty of holding a rifle or of aiming steadily in cold weather, all tend to militate against the accuracy of his individual shooting. The mere running forward in an attack makes a man's hands and arms unsteady for accurate shooting from his breathless state and heaving of the chest. Fatigue from long marching also seriously impairs the accuracy of a man's fire.

Hitherto we have supposed that the soldier has been firing at a fixed object. But if the object fired at has any movement sideways, or to or from the firer, the conditions of the shooting are far harder, and the chance of accuracy of the fire decreased.

In firing at a moving object, whether it be a man walking or a horse at a gallop, it is obvious that the object will pass over a certain distance between the moment the rifle is discharged and the time the bullet reaches it; if the object be moving across the front, the aim must be carried well in advance of it, but how much must depend, firstly, on the speed at which it is going, and secondly on the distance of the object, and the consequent time the bullet will have to travel. No fixed rules can be laid down in this matter, *practice and judgment being the only guides.*

When firing on a moving object, in order to get the correct elevation, which would not be ensured if aim were not taken on the object, the sights must be aligned on it in the usual way, and then, without pausing or dwelling on the aim, move the rifle sideways in the direction and to the extent required. If the object is advancing or retiring, the slide on the backsight must be regulated for the distance it is calculated the object will arrive at by the time the bullet reaches it.

A table is given on page 97 of the "Musketry Regulations of 1887," showing the allowance to be made with the Martini-Henry rifle when firing at an object moving across the front, at different rates, between the ranges of 100 and 500 yards. But the table is of little practical value, as men cannot remember it, and, further, they cannot estimate the distances given in the table, even if they did recollect them.

It may seem anomalous to introduce rules for firing here, but the object of doing so, and which will be also done in

other places, is to show *the ambiguousness* and therefore *the uncertainty* of the methods that have to be employed, both in the field and on the practice range, to counteract the causes which deflect the fire of individuals from its proper direction and elevation.

3. Effect on the Shooting of Imperfections in the Rifle.

So many things are required for accurate *individual* shooting that the same accuracy of firing cannot be expected from several men armed with a rifle made to a certain pattern. Every rifle has its own peculiarities and characteristics which its owner must find out and allow for. There is not a single rifle but has some defects in it, such as the graduations on the backsight (made to pattern) not being exactly suited to the rifle, both the sights not being exactly over the axis of the barrel, etc.

Rifles are not and cannot be identical; however carefully they may have been made, there always exists some slight differences in the dimensions of the bore, the rifling, the chamber, in the aiming apparatus, in the attachment of the fittings, the adjustment of the breech-closing apparatus, or in the more or less homogeneity or elasticity of the metal, etc. These differences, small as they are, affect the muzzle velocity, and, therefore, the range and flatness of the trajectory, and are sufficient, when acting together, to cause apparently similar rifles to fire with very different accuracies. If the soldier knows his weapon, he will know whether it habitually carries to the right or left, or above or below the point aimed at, and he can try to correct these particular deviations by using his judgment and experience in aiming. But it is necessary that the corrections to be made should not be large, because a soldier ought to have confidence in his weapon, and to be conscious of its accuracy. Thus before rifles are issued they ought to be carefully tested, and corrected, if necessary.

The great thing aimed at is uniformity of manufacture, so as to *always* obtain certain, nearly constant and uniform results at each range, in order that we may know what we have to deal with. If we get very different results for each rifle we can never rely on the weapon for a certain effect, and we lose that greatest of all moral advantages—the confidence of the

soldier in his weapon. However, for facility and cheapness of manufacture, certain limits of errors are allowed both in the rifle and its ammunition, which compel us to admit of certain limits of error in our shooting.

The *jump* or "throw-up" of a rifle is independent of the soldier, but it can be made fairly constant by taking care that the rifle is held to the shoulder in such a way as to give a constant resistance. It, however, *is not constant*, but varies with the angle of elevation, with the recoil (or muzzle velocity), with the way in which the rifle is held, with the position of the left hand, and with the attitude of the firer—whether standing, kneeling, sitting, or lying down. Consequently *the graduations engraved on the backsight can only be approximate guides to the requisite elevation.**

It is found that rifles experience, whilst being fired, independently of the jump, some deviations in both vertical and horizontal directions in such a way as to cause the muzzle to describe a kind of elliptical spiral, of which the greater axis is vertical. Thus, according to the position of the muzzle on the spiral when the projectile leaves the barrel, the bullet will be deviated in a lateral and longitudinal direction more and more as the range increases. This movement may or may not correct the effect of drift, but its amount is decreased as the weight of the barrel is increased, and by the rifle being held firmly against some steady rest. It is due to a want of symmetry in the distribution of the metal of the rifle, and hence is felt less in the Martini-Henry rifle (all the parts of which are nearly symmetrical on either side of the axis of the barrel) than in bolt-action rifles, which have a bolt arrangement with a projecting handle on one side by which the breech is opened and closed. The wrench caused in the barrel by the projectile being first forced along the grooves must also be a constant deviatory cause of error.

The graduations on the backsight are found practically by means of a great number of experiments, the rifle being fired from a rest.

The sights being badly manufactured, graduated, fixed on.

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* It must never be forgotten that *the graduations on the backsight are only approximative guides*. The truth of this will be more apparent as we go on, and see the number of things which affect the fire of a rifle. Few people, however, realize this important fact.

not being vertically over the axis of the barrel, or being too brilliant, so as to dazzle the eye, are very common sources of error.

As regards these defects in sighting it may sometimes occur that the rifle is not accurately sighted as to elevation, and consequently may carry a little high or low. As the marks on the leaf, denoting the height to which the slide should be raised for different distances, are not always exactly in the right place to suit the rifle (the sights being all made to one pattern), at target practice, attention should be paid to each shot; if *most* of the shots go low the sight should be raised a little, if too high the reverse. Again, the sights are not always in the proper line; if the backsight be to the right, the rifle will carry to the right; if the foresight be to the right it will carry to the left; and *vice versâ*. These defects are remedied by aiming in the contrary direction. This is all very well at target practice, but in the field the enemy will not let us know the result of our shooting, and hence any such errors will tell to their full effect.

If the foresight has been accidentally bent by any means, the effect is to bring the point of it to one side and lower, and the result on the fire would be to increase the elevation (and therefore range) and to make the bullet deflect in the opposite direction to the inclination of the foresight.

A back-sight bent to one side has the same effect as if it were inclined in the same direction as the bend; but if it is only bent backwards or forwards, the bullet strikes low.

Hence, both the sights must be carefully protected from being bent, blunted or otherwise injured; and the leaf of the backsight should not be folded down with the slide up.

The back-sight is graduated for level ground—a rare condition,—and a lower elevation is required for a given range when we are firing up or down hill. Then, again, the backsight is also graduated for a given normal cartridge, and normal condition of atmosphere, &c., and hence the graduations will not be correct if there is any alteration in the former weight of the bullet or charge, or in the envelope, or in the atmospheric conditions.

The right-handed rotation imparted to the bullets by the grooves in the barrel, causes it to *drift* to the right for reasons which cannot be gone into here; the amount of this drift for the Martini-Henry bullet at different ranges is given in Table I. on page 9, and we see that it increases more rapidly

than the range.* The drift for a given range is sometimes corrected by the position of the notch of the backsight; the 500 yards range was the one chosen for the first pattern of the Martini-Henry rifle, and thus, from this cause alone, for ranges under this distance, the bullet tended to go rather to the left of the point aimed at, and at greater ranges to the right. But this correction of the drift for a particular range, causes a displacement of the backsight, making it no longer vertically over the axis of the barrel, and makes the sighting, from that cause alone, vary for all other ranges.

In the last pattern of the Martini-Henry rifle, this correction of the drift for a given range has given place to another method. The backsight bed is now soldered on to the barrel in such a position that when the leaf is raised, it is inclined to the left 1° 6′ with the vertical line through the axis of the bore. This inclination is intended to correct the permanent deflection due to the rifling, but it does not do so altogether. It gives only a more approximate correction than the method given above, but does not altogether eliminate the effects of drift, and hence, many of the observations already made still apply, but with less force.†

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* These amounts appear to be incorrect, when compared with the drift of the rifles of other nations. Thus taking the American and French rifles, we have—

For the American rifle:

Ranges, in yards	100	200	300	400	500	600	700	800	900	1,000
Drift, in feet	0.095	0.110	0.233	0.417	0.796	1.311	2.203	3.110	4.085	5.166

For the French Rifle:

Range, in mètres..	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,700	1,800
Drift, in feet ..	$6\frac{1}{2}$	$9\frac{3}{4}$	13	$16\frac{1}{4}$	$22\frac{3}{4}$	$29\frac{1}{4}$	39	$48\frac{3}{4}$	60

1 metre being equal to nearly $1\frac{1}{10}$ yards.

The drift of the English rifle is not likely to be so very much larger than those of either of the above rifles, as stated.

† The only means of accurately correcting the drift with the backsight, is for the notch of the backsight to move sideways by means of the slide, carrying the notch, working in a suitable groove cut in the leaf of the backsight. Such a method would seem an improvement on the present one. It is used in the American and Belgian rifles.

The temperature of the rifle affects the shooting considerably. Metal expands with heat and contracts with cold, and the effect of the barrel becoming hot by prolonged continuous firing is to expand the metal inside as well as outside, and therefore to increase the size of the bore. As the bore expands the sectional area of the bullet (which is made to fit the barrel by being "set up" with the blow given it by the sudden conversion of the powder charge into gas), is increased, and therefore the retardation which it suffers. Hence no two shots can be fired under the same conditions.

After each shot the powder leaves in the barrel a variable quantity (of about six-tenths of the original charge) of solid moist residue of a black colour, called the *fouling*. After a short time this residue collects so much, especially in the grooves, as to seriously affect the fire; for this reason the grooves should be as shallow as possible. The smaller the calibre the greater is the chance of this evil, because the quantity of fouling for the same amount of charge remains the same while it is spread over a smaller surface. As the barrel gets hotter, the fouling dries and cakes, and thus the bullet, in forcing its way out through the barrel, meets with greater resistance, giving a smaller muzzle velocity and, therefore, a greater curvature of the trajectory for a given range, and consequently an increase of elevation will be required. On a hot day this increase is generally necessary, even so soon as after the second or third shot.

If the bore be allowed to become rusty* the resistance to the passage of the bullet will be increased, its proper expansion will be prevented, its rotation impaired, and it will leave the barrel with a reduced muzzle velocity.

The amount of pressure required to release the trigger in firing is called the "pull off," and should be between 6 and 8 lbs. The greater it is the more it will cause the hand of the firer to tremble. A 6 lbs. pull off is considered the smallest amount compatible with the rough usage which a military rifle has to undergo.

If the bore is not symmetrical with the exterior, the want of uniformity in the distribution of the metal of the barrel will be a source of error by causing an irregularity in the heating and expansion of the metal, and in the wave of metal caused by the passage of the bullet. Permanent projections on the barrel have the same effect. Again, if the bands,

* Rust is caused by the joint effects of moisture and air; and hence keeping the bore perfectly dry is the surest way of preventing it.

which fasten the barrel to the stock, are too tight they also prevent expansion and check the wave of the metal caused by the bullet forcing its way out, and thus check the bullet in its passage through the barrel.

Irregularity of fire is also caused by any dents or bends that the barrel has received*; by the calibre having been enlarged by bad cleaning, especially towards the muzzle; by the rifling having been scratched, leaded or rusted; by the muzzle having been damaged; by the barrel being choked (or even partially so) by dirt, sand, &c. The barrels of rifles are often seriously damaged, especially at the muzzle, and also the foresights, by their being placed forcibly in a rack, or from having been carelessly piled so that they fall down.

4. Effect on the Shooting of Imperfection in the Ammunition.

Although uniformity of manufacture is aimed at in the making up of the ammunition in order to obtain definite and nearly constant and uniform results so as to know what we have to deal with, and to give confidence to the soldier in his weapon, yet the cartridges cannot, any more than our rifles, be always made absolutely exactly alike; while further, in order to obtain facility and cheapness in manufacture, certain limits of error are recognised and allowed both in the weights of the bullet and of the powder charge, which, though small, are yet sufficient to make considerable differences in the shooting, because the muzzle velocities of different bullets cannot be the same. The mean muzzle velocity aimed at with the Martini-Henry rifle and ammunition is 1,315 feet a second, and any difference from this will cause a corresponding change in range and in the position of the point at which the bullet strikes the target. The following table, showing the mean differences in elevation of point hit, and in range, for each 10 f.s. of change in muzzle velocity, has been worked out for the American rifle and ammunition.

TABLE III.

Range, in yards	100	200	300	400	500	600	700	800	900	1,000
Change on target, in inches	0·2	0·6	1·5	2·4	4·2	6·2	8·8	11·7	15·1	19·9
Change in range, in yards	1·7	2·2	2·8	3·1	4·2	5·0	5·5	5·8	6·2	6·5

* Therefore men ought not to be allowed to carry weights with their rifles.

The average weight of the Martini-Henry bullet is 480 grains, and may be 2 grains more or less, but the difference in range, however, due to a difference of 2 grains in the weight of the bullet, is comparatively small. The charge being the same, the heavier the bullet, the less retardation it suffers, and the lighter the bullet the greater is its muzzle velocity, and consequently within small limits of weight the difference in range due to it is small, except at the longer ranges.

The bullet must be homogeneous. This is very well ensured by moulding the bullets by compression as is now done. If the bullet is cast, hollows may occur inside it which throw the centre of gravity out to one side of the longer axis of the bullet, and which would thus be a cause of considerable error.

The uniformity of the shape of the bullet is an important item. Any damage to the form of the bullet, especially on the head, increases the resistance, and therefore affects its flight. The lead in the Martini-Henry bullet is hardened with about 8 per cent. of tin to lessen any chance of such damage, to prevent any inordinate setting up of the bullet by the force of the explosion, and also to increase the penetrative power of the bullet.

Changes in the diameter of the bullet cause it to fit more or less tightly the bore of the rifle, which influences the velocity, and, independently of that, the accuracy of the fire.

The average weight of the powder charge of the Martini-Henry cartridge is 85 grains, but it may be 2 grains more or less. These 2 grains of powder make a great difference in the range at the shorter and medium distances, but at long distances any slight variations in the powder charge produce little if any effect, on account of the variation of the muzzle velocity due to this cause being neutralised by the resistance of the air. The size of the grains of the powder used in the Martini-Henry ammunition varies from "12 to 20 mesh," and the density of the powder used between 1·72 and 1·75, both of which may cause a variation in the muzzle velocity from 1,240 to 1,340 f.s. No two cartridges give the same muzzle velocity, and sometimes, in one packet of ten cartridges alone, there is a difference of 50 f.s. between the highest and lowest muzzle velocities.

The size of the grains and the density of the powder are very important factors. The smaller the grain and the less the density, the quicker the powder burns, and the more sudden is its initial effect. Every rifle requires its special charge and kind of powder to get the best effect, and a

quicker acting powder will often give a smaller final result—*i.e.*, a lower muzzle velocity—than a slower burning one. A rifle, which resists the passage of a bullet, requires a denser and slower burning and acting powder than a smooth bore.

Powder in manufacture generally varies in strength, proportion of ingredients, size of grains, density, &c., and so the different *batches* of powder are usually mixed or blended together before being issued, to procure a powder of the average strength and density required. Powder made in one year usually has a different muzzle velocity than that made in another, while it deteriorates from age or from being kept in a damp place. In some experiments on infantry fire made in 1879, it was found that the muzzle velocity of the Martini-Henry rifle ammunition (made some years before) varied from 1,240 to 1,300 f.s., and as the backsight was graduated for a higher muzzle velocity (1,320 f.s.) its graduations proved too low and affected the musketry experiments throughout. Hence, we see that the graduations on the backsight can only be approximate guides.

Powder is a mechanical mixture of sulphur, saltpetre, and charcoal, and however carefully these ingredients may have been weighed and mixed, the proportions may vary somewhat, in different parts of the same batch. Thus our Government powder is said to contain 75 p.c. of saltpetre, 10 of sulphur, and 15 of charcoal; but in samples taken from the top and bottom of a barrel by Sir F. A. Abel, one sample proved on analysis to have almost exactly 75 p.c. of saltpetre, and another only 74½ p.c.; one contained 10 and the other 10¼ p.c. of sulphur; and one had ¾ p.c. more charcoal than the other. It is not to be expected, therefore, that such powder will give absolutely equal results, other conditions being the same.

The variable amount of damp found in powder, and which increases with the time elapsed since it has been made, affects its character very much. The damper it is the worse is the fouling and the shooting, and the lower is the muzzle velocity, because much of the heat of explosion is absorbed in converting the water into steam, instead of expanding the powder gas. Powder readily absorbs moisture from the air if left exposed to its influence, or becomes quickly dried by exposure in a warm, dry, atmosphere. The exposure of powder for 3 days in an open vessel, in a room heated by a stove day and night, will increase the muzzle velocity about 50 f.s. and exposure for the same period in air saturated with moisture by rain (but the powder sheltered from the rain), will

decrease the muzzle velocity to nearly the same extent. Such extreme conditions will, of course, not occur with cartridges carefully manufactured or reloaded (if solid cases are used), but moderate changes in the muzzle velocity from moisture cannot be prevented.

The object of the lubricating beeswax wad in the Martini-Henry cartridge is to prevent any escape of gas round the bullet and to reduce the effect of fouling by cleaning out the barrel somewhat during its passage along the barrel.*

The nature of the lubricant used is of importance. If it melts or is of an oily nature it gets into the powder and weakens its action. Beeswax has been found to be better able to stand all climates than any other material of like nature.

The cartridge cases are made up and filled with the powder, and wads, and then the bullet is pressed in to fit a certain gauge. If the density of the powder is lighter than the normal it takes up more room than it should, and when the bullet is pushed home it is compressed and some of it is crushed to dust; a light density powder crumbles also to a certain extent with keeping. This powder dust increases the rate of ignition, and therefore the initial pressure of the gas. If the density of the powder is greater than the normal there is an air space left in the cartridge the effect of which is to reduce the gas pressure and therefore the muzzle velocity. The effect of a dented cartridge is the same, and hence it is just as important to preserve the form of the cartridge as the form of the bullet. For this reason, solid drawn cartridges are better than the rolled ones now used by us, as they fit the chamber better, have less air spaces naturally, and are not so easily dented. These solid drawn cartridges have been found to give as much as 70 f.s. greater muzzle velocity than the present rolled ones.† (See note on page 44).

Changes in the exterior diameter of the cartridge case affect the closeness with which it is supported by the sides of

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* The beeswax wad does not prevent fouling by lubricating the barrel, because the wads picked up after the firing weigh the same as before being fired. The present hollow in the wad has been found to be a mistake, as in hot weather it allows the wad to contract from heat, and so cause an air-space in the cartridge which reduces the muzzle velocity. A thick compressed wad of *papier maché* soaked in melted beeswax has also been found to give better results than the pure wax wad. The new wad for the Enfield-Martini rifle is $\frac{1}{4}$-inch thick, consisting of $\frac{1}{8}$ inch of hard cardboard next the powder, and $\frac{1}{8}$ inch of beeswax next the bullet.

† The advantages of the solid-drawn cartridge has at length been

the chamber, and, therefore, alter the amount of force lost in expanding it; this results in diminishing, to a greater or less extent, the velocity of the bullet. Upon the interior diameter and upon the length of the cartridge case depend the amount of compression which the powder receives; this and the degree of crimp to the case around the bullet, also affect the initial velocity.

The Government powder in the Martini-Henry cartridges (principally from the varying size of the grains, the density, and the quantities of dust powder in the charges) gives a muzzle velocity varying between 1,240 and 1,340 f.s., and hence uniformity of fire cannot ever be expected, nor can the graduations of the backsight be even looked on as more than mere approximate guides.

The advantage of a high muzzle velocity is that for a given bullet it requires a less elevation for a given range, from giving a flatter trajectory and therefore greater dangerous zones, so that a high muzzle velocity is one cause of efficiency of fire which should be aimed at, especially at short ranges, though other causes, such as the weight and shape of the bullet also influence the question.

Another advantage of a high muzzle velocity is that it gives a greater striking velocity. The striking energy of a bullet depends on its weight and on the square of the velocity with which it strikes. As the weight of the bullet practically remains constant, its striking energy, which governs its power of penetration, depends on the striking velocity squared.

The deviatory causes in shooting, extraneous to the rifle and ammunition, have greater effect and cause greater errors as the muzzle velocity decreases.

The amount of fouling left in the barrel after each shot depends on the materials of the cartridge and on the perfection of the manufacture of the powder. Inferior powder (*i.e.*, powder of low density, with much damp in it, etc.), causes an amount of fouling which very soon reduces the accuracy of the fire.

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recognised in England, though it has long been used abroad. It is to be the cartridge for our future armament. Being air-tight, it preserves the powder charge better from moisture; it does not require such heavy ammunition boxes as the present ones, as it is harder to damage; it can be refilled many times by hand machines; and it is the only kind of cartridge that can be used with machine guns. When the solid drawn cartridge is introduced, it is to be used with infantry rifles, cavalry carbines, and machine guns,—the carbine being altered to suit it,—so as to have only one kind of ammunition in the field,—a most important point.

5. Effect on the Shooting of Changes in Atmospheric Conditions.*

The backsight of the Martini-Henry rifle is theoretically supposed to be graduated for the particular temperature of 62° Fahr., a barometric pressure of 30 inches, for such a state of air in which one cubic foot of air weighs 534·22 grains, and when the force of gravity is equal to 32·1908.

If the temperature of the air increases or decreases, the density of the air is respectively diminished or increased, and hence the graduations on the backsight will be respectively too high or too low, that is, while using the same elevation, the range will be increased or decreased respectively, the other conditions remaining the same.

If the barometer rises or falls, the other conditions remaining constant, it means that the air is more or less dense respectively, and the graduation will be too low or too high, *i.e.*, the range will decrease or increase with the same elevation.

The state of the atmosphere is a very important point as regards the elevation to be used, fine days often requiring as much as $\frac{1}{20}$th of an inch higher elevation than damp days for exactly the same range. The reason of this is that on wet days, the barometer is low and the humidity of the air (*i.e.* the water vapour in the air) by its elastic force, further diminishes the density and resistance of the air, and so increases the range for the same elevation. The state of the atmosphere also affects the powder charge, causing the same elevation to give different ranges in summer and winter. Taking the average of one year only, it was found at the Royal Laboratory that the mean muzzle velocity of the Martini-Henry rifle from April to September was 1,323 f.s., while from October to March it was only 1,300 f.s., this difference was principally due to the different states of dryness of the powder. For this reason solid drawn cartridges are better than the rolled ones, as they keep out the damp better.

Rain and snow increase the density of the air and produce an opposite result to humidity.

The higher we are above the mean sea level the less dense is the air and the less powerful is gravity,† and the elevation

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* See also Appendix I.

† For points above the earth's surface, the force of gravity varies approximately inversely as the square of the distance from the centre of the earth. The force of gravity also alters with the latitude, being greatest at the poles and least at the equator.

has to be largely reduced for a given range. This is well-known in the hills of India. The rate of ignition of the powder too is affected by the less pressure of air, the higher we go the slower is the burning, which requires an increase of the elevation for a given range.

On a hot dry day the fouling dries rapidly in the bore and increases the resistance, reducing the muzzle velocity and range, and hence necessitating a higher elevation than on a damp day when the fouling is moist, which, then acting as a lubricant, reduces the resistance to the bullet in its passage through the barrel.

As the temperature of the air increases, the general effect is, as a rule, to increase the absolute amount of moisture in the air, and therefore, for the reasons given above, to increase the velocity.

Increase of temperature also increases the muzzle velocity, in that less of the work of the powder gas is absorbed in heating the barrel, and a greater amount is available for its effect upon the bullet. This will produce, in cold weather a considerable variation between the earlier and later rounds fired, which in warmer weather is not so noticeable.

For all these reasons, we see that the graduations on the backsight can only be approximate guides.

A glare in the eyes from the reflection of the sun off the ground, waviness caused by heated vapour rising from the ground, smoke, fogs, mists, etc., all interfere with the shooting. Intense cold too prevents the rifle being properly used. Dust and powder smoke being driven into the eyes, or a strong wind blowing into the firer's face, which might happen on service, is another cause of error in shooting. The motion caused to the air immediately surrounding a barrel heated by much firing, often makes the object aimed at appear indefinite, and so affects the shooting.

The effect of clouds or bright sunshine is often considerable. On bright hot days there is greater probability of local currents, produced by the differently heated ground, which may cause unaccountable deflections. On these days also there is a possibility of portions of the range being in shade: that particular ground will therefore be cooler, and consequently the adjacent air, being of greater density, will offer increased resistance to the bullet. Under these conditions there is greater probability of inaccurate shooting,

When the day is overcast, the light being of a dull grey, and evenly diffused, it is more likely that the air over the

whole range will be of a uniform temperature and free from local eddies. Such weather is the most favourable for accurate practice.

When the light is alternately bright and then shaded by clouds, the difficulties confronting the firer are much increased. These changes of light, besides affecting the conditions which cause a deflection of the bullet, also have a considerable influence upon the manner of aiming.

Changes in the brightness of the light seem to affect the aiming of different men in various ways; suggestions which might prove of value in many cases might therefore prove erroneous in others. It is, however, generally found that when the sun is shining from the left it lightens up the left side of the foresight and the right side of the notch of the backsight; the result is that in taking aim, one is apt to be guided by those brilliant spots instead of the real centres of the sights, and the axis will be directed to the right; while on the other hand, when the sun is on the right, we shall be liable in aiming to direct the axis to the left. Blackening the sight is the only means of preventing the possibility of any error arising from this cause.

When the sun shines both on the sights and on the object, the fine point of the foresight is very distinctly seen, and consequently a little more elevation is required than on a dull day, when owing to the foresight being less clearly defined, more of it is unconsciously taken up into the alignments. This error is less liable to occur when a full foresight is used than for a fine foresight.

Up to this point we have not referred to *wind*. But there is hardly a day without a certain amount of wind, and so we must consider its effects. According to the direction of the wind as regards the direction in which the soldier is firing, it is called a side, a back, or a head wind.

Wind, which is air in motion, will, by its pressure, affect the progress of the bullet, driving it to the left of the line of fire if blowing from the right and *vice versâ*. The effect of a constant side wind, giving a constant side pressure, is to make the bullet move sideways in its course in a more rapid ratio than the range (see Table I.), and therefore in a horizontal curve (of much the same nature as the vertical curve of the trajectory, though much less bent) and *not in a straight line*, for exactly the same reason as the vertical trajectory is a curve—the constant pressure of the wind replacing the constant force of gravity.

If the wind is blowing from the front, it will add to the resistance, and consequently decrease the range of the bullet; and if from the rear, by diminishing the resistance, it will enable the bullet to fly further. As no fixed rules can be laid down to guide the soldier as to the amount of allowance he should make for the wind, he must gain experience by his practice, noticing how much it is necessary under different conditions to direct his line of fire to that side from which the wind is blowing when dealing with a side wind, only giving his rifle a little more or less elevation when dealing with a wind from the front or rear; always taking into consideration three things, *the strength and direction of the wind, and the distance of the object at which he is firing*, since on the latter will depend the length of time the wind will have to act.

He should notice, if possible, where *the greater number* of his shots strike, and make more or less allowance, as he finds it necessary; and he should bear in mind that the effect of a wind from the front or rear is much less than that of a side wind, which acts on a larger surface of the bullet; and also that the effect of a wind from the front is greater than that of a wind from the rear. Further, if a considerable dip exists between the firing point and the objective, the force of the wind over the dip will be greater than if the dip did not exist.

A strong wind also increases the density of the air, and therefore its resistance, and hence when a strong wind is blowing, and a great deal of wind-gauge is necessary, a little extra elevation is generally required.

No satisfactory deviations due to wind have been made out for the English rifle and ammunition, but the French regulations say that for the same range the deviations are proportional to the strength (or velocity) of the wind, and thus they only give the deviations (laterally and in range) for a wind moving with a velocity of a mètre (3·28 feet) a second, *i.e.*, for a light air. The deviations for any other velocity are found by multiplying the given deviations by the velocity of the wind in mètres per second, the velocity being measured, not in the direction of the wind, but at right angles and parallel to the direction of the fire. The following table gives the lateral deviations of the French bullet under a side wind moving with a velocity of 1 mètre per second; with a head or rear wind of the same velocity, the deviations in range are said to be 3 times the lateral ones with a side wind.

TABLE IV.

Range.	Lateral deviation.	Range.	Lateral deviation.	Range.	Lateral deviation.	Range.	Lateral deviation.
mètres	mètres	mètres	mètres	mètres	mètres	mètres	mètres
100	0·02	600	0·72	1100	2·42	1600	5·12
200	0·08	700	0·98	1200	2·88	1700	5·78
300	0·18	890	1·28	1300	3·38	1800	6·48
400	0·32	900	1·62	1400	3·92		
500	0·50	1000	2·00	1500	4·50		

For any other direction of the wind than at right angles or parallel to the line of fire, the figures in the tables must be multiplied by the *sine* of the angle of incidence of the wind; the alteration in range will be found by multiplying them by 3 times the *cosine* of the angle of incidence. These figures and calculations show that the allowance for wind in the field can only be guess work.

There is one method of making allowance for a side wind at all ranges, namely, by directing the line of sight to the right or left of the object as the case may be. In this method in order to get the correct elevation, which would not be ensured if aim were not first taken on the object, the soldier must first align the sights on it in the ordinary way, and then without pausing or dwelling on the aim, move the rifle sideways in the direction and to the extent required.

There is a second method of allowing for the wind by means of a *wind-gauge*, which is a horizontal scale marked on the slide of the backsight, which enables the firer to direct his aim straight on the object, and at the same time to deflect his line of fire to the right or left, as existing conditions of wind may require. From the construction of the backsight used on the Martini-Henry rifle, for ranges of 400 yards and under, allowance for wind can only be made by aiming to the right or left, while for greater ranges, this method or the wind-gauge can be used. If the line of sight be taken over the right graduations of the wind-gauge the line of fire will be directed to the right, and *vice versâ*.

In using the wind-gauge the firer is very apt to incline the back-sight. This must be specially guarded against.

Another great disadvantage of firing in a wind, is that it

causes the rifle to shake during the process of aiming, unless it can be rested on some solid object.

In the above considerations, regarding the allowance for wind, we have supposed a constant wind pressure, but as the force of the wind is constantly varying, as the wind nearly always blows in gusts, the difficulty of making allowance is greatly increased.

6. Effect on the Shooting of the Attitude of the Firer, and of the Method of Executing the Fire.

The accuracy of the fire of a rifle differs with the attitude of the firer, whether he is standing, kneeling, sitting or lying down. In the last three cases, he has either the support of his knee, or of the ground respectively for his elbows, but from experiments, it has been found that after rapid and fatiguing movements, as in an attack, at the shorter ranges, better practice *on targets* in a rapid fire is made in the standing and kneeling positions than when lying down, on account of the heaving of the chest against the ground in the last-named attitude.

Slight changes in position, even in the same attitude, affect the shooting considerably, especially at the longer ranges; each change affects at least the appearance of the sights or the touch upon the trigger, and it may also alter the relative tension or relaxation of the muscles. A varying position of the left hand under the barrel, and of the butt of the rifle against the shoulder also affects the accuracy of an individual fire.

The accuracy of shooting is different according as the bayonet is fixed to the muzzle of the rifle or not, or according as the rifle is rested against or supported on a steady object or not. Fixing the bayonets adds more weight to the rifle, lessening the recoil, and from the forward position of the extra weight, the jump is also considerably reduced, but it throws out the balance of the rifle, and makes it harder to hold steadily to the shoulder especially in a wind.

The French regulations state that when the sword-bayonet is fixed to the Gras rifle, the bullets are deviated 0.50 mètre to the left at 200 mètres and also 0.30 mètre low. At the same range the deviation with the German rifle is 0.42 mètre to the left and 0.27 mètre low. The deviation to the left is caused by the bayonets being fixed to the left of the barrel; in the new Enfield-Martini rifle the bayonet is to be fixed

under the barrel, which will tend still more to keep the fire low. This shows that the jump is decreased by fixing the bayonet. It is useless finding out the deviation caused by the bayonet at longer ranges, as it would not be fixed until the enemy is quite close.

Then again, as we shall see in Part II., volley and independent firing give different results not only at the same range and for the same number of rounds, but for different strengths of the body of men firing.

7. Effect on the Shooting of the Duration and Rapidity of the Fire.

The duration and rapidity of the fire acts injuriously on the accuracy of the fire, independently of the disturbing moral effect it has on the firer, by fatiguing him, by causing him more and more to fear the recoil, and by not giving him sufficient time to aim. In a rapid fire of considerable duration, the rifle gets hot, the grooves get leaded and filled with caked fouling, the flashes cause a kind of glare, which renders aiming more difficult, while the atmosphere gets filled with smoke and hurts the eyes.

Résumé.

From all the above causes of error, we see that there is often a considerable difference between the actual elevation required for a given range, and that marked on the backsight. Elevation, as we have seen, is affected by variations in the density of the atmosphere, light, heat, wind, rifle, ammunition, and fouling, and the exact amount necessary only can be *guessed* by the soldier who has only those two rough guides to direct his choice—judgment and experience—in doing so.

From all these causes the bullets fired by a single man at a given range cannot possibly always fall on the same spot, but will fall over a certain space, especially in the direction of the fire, but, as most of these influences are pretty constant for the same man, the space over which his bullets fall is not very great, though it increases with the range. The space over which the bullets fall decreases with the increase of the skill of the firer. The bullets falling thus must increase considerably the theoretical dangerous zone of each range in practice when a large number of rounds are fired at the same range.

In the field, the accuracy of the fire cannot be perceived, and therefore adjustments or allowances for wind, wrong elevation, movement of object fired at, and any deviation in the fire, cannot be made with any approach to certainty. Besides this, the allowance for the effect of wind and the movement of the object aimed at, entirely depends on the judgment and experience (two very rough guides) of the soldier. Hence arises the almost impossibility of certainly obtaining accurate *individual* firing in the field, especially at the longer ranges, and the great difficulty of getting it even on the practice ground.

Every soldier ought to correct his fire according to his observations, but it is essential to have all causes of error corrected as far as possible by the perfection of the manufacture of the rifle and ammunition, rather than having to correct them in the aiming, because in the field the distances are not exactly known, the soldier cannot see the effects of his shots, and therefore such corrections are not possible.

It seems a great pity that the Martini-Henry rifles are graduated for a fine foresight, and that therefore we accustom our men to aim with such a sight instead of a full one. A fine sight may be best for prize shooting with match rifles, but it is quite unadapted for war purposes. In the varying lights during a day, in the dusk, when a man is fatigued or excited, if the top of the foresight is injured (as it easily may be), in rapid firing, in a long continued fire, in cold weather, &c., a full sight is far better adapted for practical purposes than a fine sight. The accuracy obtainable by the Martini-Henry rifle with a fine sight, under even ordinary conditions, as compared with the results obtained by Continental weapons with full sights, does not at all warrant (especially under conditions of war) our retaining it in future weapons, when all practical considerations are against it.

NOTE. (See page 34.)—The new, solid-drawn cartridge case is said to contain a compressed pellet of powder with a central longitudinal opening. By this arrangement the powder charge burns from the centre outwards and gives off an increasing quantity of gas as the space increases behind the bullet, moving forward in the bore. In this way a more constant and uniform pressure is maintained on the base of the bullet, giving a higher muzzle velocity, while at the same time the recoil is greatly lessened.

CHAPTER IV.

DETERMINATION OF THE ACCURACY OF A RIFLE.—DIMENSIONS OF THE SHOT-GROUPINGS OF A MARTINI-HENRY RIFLE FOR INDIVIDUAL FIRE.

From what has been said, we see that, however great care may be taken to render all the conditions of fire identical, we can never obtain the same trajectory for even similar projectiles fired under apparently the same circumstances, and that the influences acting on the fire of a rifle are so diverse, that if the same man fires a series of about 50 bullets at least with the same rifle, without committing the least personal error, and while constantly aiming at the same point, these projectiles will cover, when received on a target, a more or less great *surface* or *area* called *the grouping of the shots* * If the shots are received on a vertical target, the surface covered with hits is called *the vertical grouping of the shots;* and if the bullets are allowed to pass on and to fall on a horizontal surface, or one sensibly parallel to the line of sight, *the* grouping of hits is called the *horizontal beaten surface*, or the *horizontal grouping of the shots.* The groupings of the shots are usually formed on a vertical target for individual fire, and on a horizontal surface for collective fire †. The general form of the grouping is found to be an ellipse in each case, but on a horizontal surface its longest diameter or major axis, as it is called, will be much longer, not only absolutely but also proportionately to its smallest diameter or minor axis.

The hits forming these groupings, are closer together towards the centre, where a *nucleus* is formed, while towards the edges they are further apart.

Taking all the different hits on a vertical target, we see that every bullet which does not strike the point aimed at

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* This shows the uselessness of a soldier at target practice altering his sight after *each* round, because the particular shot does not strike the *exact* point aimed at.

† By *collective fire* is meant a fire delivered from several rifles and directed on a named object.

must have, with respect to this point, an *error in height* and an *error in direction*.

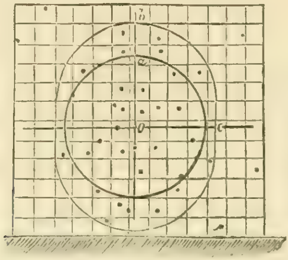

FIG. 1.

The vertical grouping of a series of shots.

o a	Radius of the circle enclosing the best half of the hits	Some abnormal hits not included.
o b	Radius of the circle enclosing all the vertical deviations	
c c	Radius of the circle enclosing all the horizontal deviations	

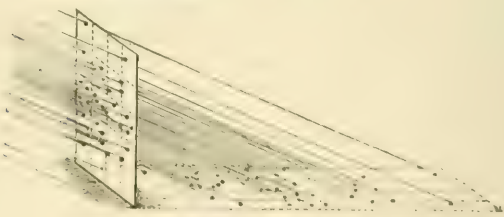

FIG. 2.

The horizontal grouping of a series of shots.

There results from the above, that we cannot fire along an isolated trajectory, and as there is no reason why the causes which influence the flight of a projectile should not act as much in one direction as in the opposite one, when a large number of shots are fired, the deviations occur in all directions, and we now require to find the curve which occupies a mean position among all the trajectories described by the bullets fired. This curve is called the *mean trajectory*, and is that which each projectile would have followed, if the causes which modified its movement had not existed. The differences between the real

and the mean trajectories are called the *errors* of the projectiles, these errors being due to the causes already enumerated.

If we conceive the range divided into a certain number of parts, then the ordinates* of the mean trajectory at the points of division, will be the mean of all the ordinates of the trajectories of the bullets fired, at the same points of division.

This mean trajectory is the one that all calculations and data are usually referred to, and it is the trajectory worked out by Bashforth's Tables. Table I. on pp. 8 and 9 refers only to the mean trajectories of the different ranges.

If we look at the manner in which the hits are grouped on a vertical or on a horizontal target, they appear at first to be very irregularly distributed, and apparently without law, but as the number of hits are increased, we shall see, on a closer study, that round a certain point which marks the mean trajectory, the shots are nearer one another than in the other parts of the target. This point is found to have the following properties:—

If we suppose a number of lines drawn at equal distances apart, and parallel to any line drawn through the central point of the group of shots, then the zones which are equidistant from the central line, will each contain the same number of hits, showing therefore, that the chances of error are the same on either side. Also the number of hits in the successive zones of the same width diminish according as the zones are more distant from the central line.

Thus the dispersion of the shots on a target is far from being arbitrary, but always follows a certain law, which allows us to draw up *tables of accuracy*, by which we can classify different arms in order of merit, supposing that they are fired under the same normal external conditions.

The construction of these tables results from certain definitions and methods of measuring the errors, which are given in "Section 3. Testing rifles and ammunition," on p. 211 of the Musketry Regulations of 1887, and to which we must now ask the reader to refer before proceeding further. However, in the following pages we shall use the word "error" instead of "deviation," as conveying more to the mind.

The point where any bullet strikes a vertical or horizontal target, is called its *point of impact* and the point where

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* The ordinate of any point in a trajectory is its height above the line of sight, measured in a direction at right angles to this latter.

the mean trajectory would strike the same target, (*i.e.*, the central point of the group of hits,) is called the *point of mean impact.*

The above errors (obtained either by direct measurement on the target, or from a diagram of the shooting, plotted to scale) permit us to appreciate the value of a fire, as regards accuracy alone. From them we can calculate the position of the point of mean impact of the mean trajectory on the target, and therefore its position with respect to the point aimed at.

The accuracy of a rifle at any given range may be defined as the probability it gives of striking an object of given dimensions at that range. It depends both on the position of the point of mean impact with regard to the point aimed at, and of the manner in which the shots are grouped around this point of mean impact.

The value of a rifle is greater for a given distance, according as the point of mean impact of the shots fired at this distance is nearer to the point aimed at, and as the shots are more concentrated round the point of mean impact.

This method of judging the accuracy of the fire of a rifle with respect to the point of mean impact, requires that diagrams of groups of shots should be made for each distance. If the target is prepared in small (3 to 6 inch) squares, then we can mark on a diagram of the target (drawn to a smaller scale on paper) the position of each hit, and the errors can then be measured to scale. The absolute errors can be measured directly from the scale or by eye after describing concentric circles, whose *radii* vary by the length of the side of a square.

The value of the mean absolute error, however, which, with a well finished rifle, allows us to judge of the skill of a firer, cannot be considered as the exact measure of the accuracy of the weapon. It frequently happens that the shots are grouped quite away from the point aimed at. If the elevation employed is too low, the shots group themselves under the point aimed at; if the line of sight is not in the plane of fire, they group to the right or left as the case may be; if the wind blows from one side all the shots are thrown to the opposite direction.

When these different causes act together, the grouping may be carried to a considerable distance from the point aimed at. The absolute error of each shot, with regard to this point, becomes then very considerable, and the mean absolute error reaches a value which might indicate a bad fire. The hits, however, can be well grouped, and in this case the weapon

should be considered accurate, and all that would be required to cause a really efficacious fire, as regards accuracy, is to neutralize the causes which have made the mass of the shots strike so far from the point aimed at.

A knowledge of the position of the point of mean impact, thus gives us the following information :—

1. We know how much and in what direction to allow in aiming to correct the fire, so as to strike the point aimed at.
2. We can see whether the fire is affected most in a vertical or in a horizontal direction at any given distance.
3. A comparison of the positions of the points of mean impact at different distances, enables us to distinguish if the causes of deviation are permanent or temporary ones.

Let us suppose, for example, that after having regulated the sights in the morning, we fire with the same sights again in the afternoon to test them, and find that all the shots strike higher, then we must conclude that either the density of the air has diminished, the weather having changed ; or that the powder is not the same, or the charges are greater ; or that a wind has been blowing from the rear which did not exist in the morning ; or that the light has changed and the firer has used more foresight than in the morning. All these circumstances can be verified, however, by weighing the charges, examining the powder, comparing the meteorological reports, &c., relative to the two trials.

If the means of the horizontal errors have altered, and if they vary irregularly according to the distance, we can conclude that the causes of deviation have themselves varied, that they have acted in an accidental or temporary manner, and that they are not inherent in the weapon. For example, a squally wind, perpendicular to the plane of fire and changing direction.

If the means of the horizontal errors vary always in the same direction and in a progressive manner with the distance, the cause can only be attributed to the weapon or to the firer. It is either due to drift or to a constant error in the aiming.

If the variations of the mean horizontal errors in the same direction do not increase with the distances, they can only be attributed to an exterior cause, such as a wind blowing laterally and in an unequal manner during the duration of the fire.

Hence we see why the position of the point of mean impact with respect to the point aimed at, gives a very imperfect idea

of the accuracy of the rifle, as the position of the point of mean impact can remain the same with very different groupings round this point.

The mean absolute error with respect to the point aimed at, measures the trueness of the rifle or the correctness of the fire. According as the whole grouping, whether it be dispersed, or concentrated, is more or less distant from the point aimed at, the rifle is said to be untrue, or true, or the fire is said to be badly or well corrected.

The dispersion or concentration of the shots with respect to one another is the best measure either of the accuracy of the aim, or of the skill of the firer when the weapon used is known to be true.

FIG. 3.

Thus let us consider four groupings, A, B, C, D (Fig. 3 obtained by a good firer with four different rifles under the same external conditions while aiming at the point P; the weapons which give the groups B and D are less accurate than those which give the groups A and C; those which give the groups A and B, are truer than those which give the groups C and D; and finally the rifle which gave the group D is neither accurate nor true.

In this case the accuracy of the different rifles depends on the perfection of their manufacture, and on that of the ammunition, while the trueness of each rifle depends on a good

disposition of the sighting apparatus (*i.e.*, the back and foresights).

Now let us suppose that these four groups have been obtained from the same weapon (an accurate one) by four different firers under the same external conditions; the fire of the two men who made the groups A and B are the best corrected, and that of the two men who made the groups A and C are the most accurate. The fire C is accurate but it is not corrected; the fire B is true but it is not accurate; the fire D is neither accurate nor correct.

In this case the accuracy of the fire depends on the manner in which the firer directs his aim, keeps it in the direction, and pulls the trigger; while the trueness of the fire depends on how the corrections have been made, that are necessary to carry out in the aiming, more or less to the right or left, and above or below the object.

A rifle is therefore only good when it is both accurate and true, and a firer is only skilful when he is able to group his shots well and to direct this group on the object to be hit. The accuracy and trueness of a rifle must be assured by its manufacture and by that of its ammunition, in order that we may have as absolute quantities as possible to deal with and the soldier have confidence in his weapon.

Now since the manner in which a rifle groups its shots is the measure of its accuracy, it is very necessary, in determining the accuracy of a rifle, to eliminate the effect of the accidental causes which make the projectile deviate from the point aimed at, and therefore for this purpose we must take *the mean absolute error with respect to the centre of the group* round which point all the shots are distributed.

The mean absolute error, taken with respect to the point of mean impact, gives a relatively more correct idea of the accuracy, than the mean absolute error taken with respect to the point aimed at; this is easily seen from Fig. 3, by examining the groups C and D, of which C is more concentrated than D, though it is further from the point aimed at. If we consider the error of the two groups with respect to P, the point aimed at, the error of group C will be greater than the error of group D, notwithstanding that the rifle which gave the group C is more accurate than that which gave the group D.

The *mean absolute error* for any range with reference to the point of mean impact, is called in England the "figure of merit" for the given range, and it is the method of comparison

used in England for the fire of different rifles. The actual horizontal and vertical errors have not been hitherto considered in the English service in estimating the comparative accuracy of two or more rifles, though, as we shall see, they are of the highest importance in considering the question of individual fire in the field.

The two columns, 2 and 3 in Table V., giving the *radii* of the circles which enclose *all* the vertical and *all* the horizontal errors, have been calculated (for want of practical information regarding them) proportionally to certain statistics given in the German Musketry Regulations for the Mauser rifle.* This method of doing so is not mathematically correct, but it is sufficiently near the truth for comparative work; the necessary data have not been obtainable to get more accurate figures.

Before finding these errors, the Germans deduct a certain percentage of hits, varying with the range, for abnormal shots; these percentages are as follows: at 100 m., 1 p.c.; at 150 m., 2; at 200 m., 3; at 250 m., 4; at 300 m., 5; at 350 m., 6; at 400 m., 7; at 500 m., 8; at 600 m., 9; at 700 m., 10; at 800 m., 11; at 900 m., 12; at 1,000 m., 13; at 1,100 m., 14; at 1,200 m., 15; at 1,300 m., 16; at 1,400 m., 17; at 1,500 m., 18; and at 1,600 m., 19 p.c.

In no German or other work has it been found why these percentages are deducted from the recorded hits before determining the values of the errors, but doubtless the necessity for doing so has been found from the immense number of experiments which the Germans have made.

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* These statistics have been found with the use of "full" sight. In England a fine sight is used because the backsight is graduated for it.

TABLE V.

Dimensions of the Shot-Groups made by the Martini-Henry Rifle on a Vertical Target.

1	2	3	4
Range, in yards.	Radius of circle enclosing all the vertical errors.	Radius of circle enclosing all the horizontal errors.	Remarks on double the horizontal and vertical errors.
Yards.	Feet.	Feet.	
50	0·11	0·11	
100	0·23	0·23	
150	0·29	0·29	
200	0·40	0·35	The size of a head.
250	0·52	0·44	
300	0·69	0·58	A little less than the width of the vulnerable part of a man.
350	0·85	0·72	
400	1·08	0·86	
450	1·17	0·94	A little more than the width of a man.
500	1·33	1·07	
550	1·50	1·20	
600	1·68	1·38	
650	1·87	1·51	A little more than the height of a kneeling man.
700	2·10	1·68	A little less than the width of two men.
750	2·30	1·81	
800	2·58	1·98	
850	2·84	2·14	Rather greater than the height of a man.
900	3·16	2·35	
950	3·57	2·60	
1000	3·85	2·78	
1050	4·37	2·99	
1100	4·68	3·20	

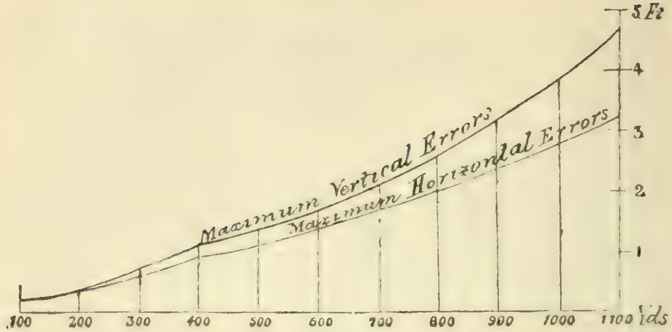

FIG. 4.

GRAPHICAL CURVE OF THE ERRORS GIVEN IN TABLE V.*

The above errors are those made by a good marksman, and it must be clearly remembered, that *these numbers are by no means absolute, but only comparative.* The accuracy of the fire varies every day, as the ammunition and as the density of the air, and consequently the retardation, varies, and according to the condition, eyesight, and skill of the firer. But the above

* Whatever results have been found by experiment from a large number of observations they should always be graphically represented by curves, to see that they present no anomalies, and to rectify them if necessary. These curves are drawn by setting off the ranges to scale along one straight line, and at the end of each range draw at right angles to this line, other lines whose lengths represent the numerical value (to any other convenient scale) of the data obtained for the range, and then join the ends of these upright lines. If there are any anomalies the numbers given by the probable or regular curve, joining the ends of the majority of the upright lines, are most likely to be right, because, as has been said, when a large number of shots have been fired, there does exist some kind of law among the results.

In results obtained by the Martini-Henry rifle, there seems to be some kind of anomaly between the results obtained up to 400 yards, and those obtained for longer ranges. This is due to the different methods of sighting used, and the alteration of the distance of the backsight from the eye, for ranges under and over 400 yards. This fact is also very plain in Table II., p. 21.

Table V. shows the folly of altering the elevation, as is often done, after each shot because it does not hit the exact spot aimed at. If the shots hit within the limit of error, that is all that can be expected. The elevation should only be altered when the successive hits indicate the fire is too high or too low generally.

numbers furnish a useful basis for comparison, and for working on.

From Table V., we see that the vertical groupings of the Martini-Henry rifle take the form of a circle up to 150 yards inclusive, and at greater distances than this, the form of an ellipse or oval, of which the greater axis is vertical. The diameters of this ellipse increase with the range, and their dimensions vary more or less, according to the degree of accuracy of shooting of each rifle, and skilfulness of the firer, for a rifle is so much the more accurate, and the firer more skilful, as this surface is smaller, *i.e.*, as the hits are better grouped.

With known ranges the limiting distance of such an individual fire, in which every shot hits, depends on the limiting vertical or horizontal error. As a general rule, an increase of the breadth of an object beyond a certain point, without a corresponding increase of height, has no sensible influence on the possibility of a single man hitting it, because the vertical errors are greater than the horizontal ones.

Four men, side by side, may be taken to represent a square with a side of 6 feet. Now suppose we want to know at what *known* range a good shot, under favourable conditions, can strike this target almost at every time. A man should not fire at such an object beyond a range at which his greatest error is 3 feet, if he wishes to hit as often as possible. From Table V. on p. 53, we see that this greatest error corresponds to a range of almost 850 yards, when a good shot will hit 89 times out 100. This corresponds very much with what we find in practice.

Similarly a man lying down can be supposed to occupy a square with a diameter of 1·5 feet and a good shot under the most favourable conditions will hit it 95 out of 100 times at a range of about 300 yards, at which the maximum error is 0·69 feet.

Now these numbers entirely depend on the range and proper elevation being known, on the point of mean impact coinciding with the point aimed at, on the man being a very good shot, no wind, and other favourable conditions which rarely exist together. In reality we must divide the results obtained by the best shots by three or four, to find those which can be expected from the mass of men, and then divide, according to French and German practice, the result by 10, to find their probable value in battle for *known ranges*, a condition rarely possible in the field. Certainly, less than $\frac{1}{30}$th or $\frac{1}{40}$th

of peace results can only be relied on in war; the Austrians say $\frac{1}{6}$th.*

All musketry data can only be approximative, and to be on the safe side we should always use the most unfavourable ones, because in the field a soldier's ammunition and rifle run so many chances of deterioration.

Thus, in all cases, we should carefully avoid placing absolute reliance on data found on the practice range, which are as a rule obtained under the most favourable conditions, by skilful and practiced men, with every aid possible to ensure accuracy of fire.

* A comparison in any war of the amount of ammunition fired away and the number of killed and wounded, shows that the number of rounds expended to every man killed and wounded, is to be reckoned by hundreds. Such would not be the case if peace results were in any way in harmony with war results. There is an old saying that "It takes a ton of lead to kill a man."

CHAPTER V.

PRACTICAL TRAJECTORIES AND THE LIMITS FOR INDIVIDUAL FIRING.

Before the Franco-German war of 1870-71, the universal idea was, that the individual skill of an average shot with his rifle was the measure of the efficacy of the fire of the masses. As, at that time, the maximum distance for effective firing was considered to be 450 yards, this idea was quite true, but after the war, when *the fire of the masses* had been found to be effective at ranges far beyond those of effective individual fire, a complete revolution took place in the German Army as to the method of using rifle fire in the field, and which has, since 1877 (when the system was first made public), been adopted *in toto* by every European power but ourselves.

The following pages, adapted to suit the Martini-Henry rifle, are principally taken from the *Revue Militaire de l'Étranger*, and they give the principles on which the German musketry regulations, and those of all other Continental powers, entirely rest. Their perfection will be seen by the solid basis on which they rest.

Connection Between the Dimensions of Shot Groupings and those of Some of the Most Usual Objectives in War.

The practical effects to be expected from an individual fire at any given range depend principally *on the connection which exists at the given range between the size of the shot group and the size of the object to be hit, and also on the distance of this shot group above the ground.* Thus we see the importance of comparing the data contained in Table V. on p. 53, with the size of the objects which are most often seen in the field in war, as well as of studying the position of the shot groupings above the line of sight when we fire at an object situated at the range exactly corresponding to the elevation used, and also at ranges which do not correspond to this elevation. This latter point is a most important one, as ranges are never exactly known in the field.

The following dimensions* may be accepted as the average

* These are the usual dimensions accepted abroad

height and width of the most usual objectives met with in war.

	Feet.
The height of a man standing	5·50
,, ,, ,, ,, running forward	5·33
,, ,, ,, ,, kneeling	3·67
,, ,, ,, ,, lying down in the open	1·50
,, ,, ,, ,, lying down under cover	1·17
,, ,, ,, a mounted man standing still	8·00
,, ,, ,, ,, ,, riding at a rapid pace	6·67
Total width of a man	1·75
Width of the vulnerable part of a man	1·33
,, a group of 2 men in close order	3·56
,, ,, 3 ,, ,,	5·25
,, a horse with rider	3·00

If the group of shots is well placed, the bullets will always strike the object, so long as the shot group has either a smaller, or the same extent, of surface as the object, but when that distance is reached where the shot group has a larger surface than the objective, then many of the bullets, *though well directed*, will miss the mark without any fault of the firer, and an uncertain fire is the result. The proportion of misses increases in proportion as the extent of the shot group exceeds that of the objective. Thus in order to put 97 per cent. of the shots fired into an object at 200 yards, it must be at least 0·7ft. wide and 0·8ft. high (see Table V.), always supposing the group is well placed.

General Form of the Dispersion of Shots of an Individual Fire.

When a large number of shots have been fired, the mean trajectory of these occupies a mean position passing through the point of mean impact, and is the theoretical trajectory of the whole. We will suppose that it passes through the spot aimed at on the object to be hit. The ellipse drawn round this point with diameters equal to twice the greatest vertical and horizontal errors respectively for the range will include all the hits, less the deduction made for abnormal shots.

As we go from 100 yards to 200, 300, 400 yards, etc., we find that the ellipses increase with the distance, but in a more rapid ratio. Now practically for rifles, every trajectory includes in itself the trajectories of the ower ranges. This is

known as *the principle of the rigidity of the trajectory*, the error caused by this supposition being inappreciable. Hence, if we trace the mean trajectory for any long range, say for 1,000 yards, and draw the shot groups at each range with their centres lying in the mean trajectory, and join their circumferences, we obtain a "bundle" of trajectories, which form a kind of curved cone, which is very small in section at the shortest ranges, and goes on enlarging at the greater ones, just like a jet of water from a fire engine.

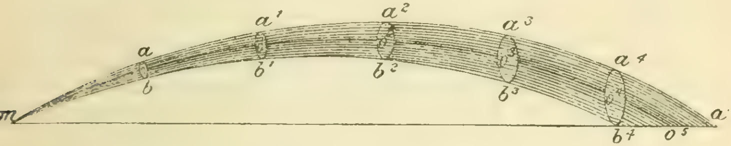

FIG. 5.

ma .... a_5 Upper Trajectory.
mo .... o_5 Mean ,,
mb .... b_4 Lower ,,

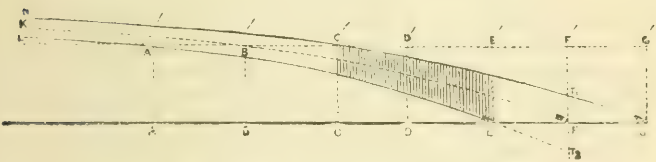

FIG. 6.

HC′G Upper Trajectory.
LA′E Lower ,,
KB′F Mean ,,
The line A′B′C′ . . . G′ is at the height of the objective above the ground line ABC . . . G.
AG=Total dangerous zone, exclusive of ricochets.
AE=Grazed zone.
AC=Rear part of dangerous zone.
CE=Central part of dangerous zone, or zone grazed by the whole cone.
EG=Front part of dangerous zone, or beaten zone.
D is the central point of the zone CE.

The position of the shot groups with respect to the line of sight, and the relative areas of these groups at the different distances, show that the trajectories of a series of shots form an imaginary solid, like a curved cone, of an elliptical section, of which the apex is at the muzzle of the rifle, and which opens out according as the distance of the firer from the

target increases. This imaginary curved cone is called *the cone of dispersion of the shots*, and the curve which forms the axis of this cone, is what we have called the mean trajectory; the shot groups are the sections made in the cone by vertical surfaces, whilst the beaten ground is determined by the intersection of the cone with the ground.

"If all the trajectories taken together be thus pictured mentally as a solid curved cone, lengthened out according to the elevation given to it, and having its terminal vertical area rapidly increased as it is directed on more and more distant objects, then the meaning of the term 'shot groups' at various distances will become apparent, and they will be seen to be merely a series of vertical sections taken through the imaginary solid cone at the different distances. Looking thus at the subject, the conclusion arrived at from the foregoing investigation may be defined under the statement, that, in individual firing, the relation between an objective and a shot group is the relation that exists between their respective areas at the distance fired at."

The knowledge at each range of the maximum errors, allows us to judge accurately the chances of hitting an object of known dimensions, while the theoretical or mean trajectories are only of theoretical value to us in calculating the mean height of the bullets above the line of sight in their flight for different ranges, and therefore for practical purposes we must use instead of them the *practical trajectories*, which may be defined as the mean trajectories surrounded by the cone of dispersion, containing all the remaining trajectories.

Position of the Shot Groupings with respect to the line of sight.

The position of a shot group is determined by that of the centre of its figure, that is to say, of its point of mean impact.

The ordinates* of the mean trajectory (which passes through the centre of the shot group), express the distances of the centres of the shot groups from the line of sight. The table in Appendix II. gives the heights of the ordinates, above the line of sight, of the mean trajectories or centres of the shot groups of the Martini-Henry rifle for different ranges 100 yards apart, for every 50 yards.

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* See footnote on page 47.

Ordinates of the extreme trajectories of the cone.

The general form of the cone of dispersion is usually expressed by the ordinates of its extreme (upper and lower,) and mean trajectories; and the cone of dispersion is generally graphically shown by drawing these three lines. (See Plate I, at end of book).

The ordinates of the extreme trajectories can be deduced from that of the mean trajectory, because twice the greatest vertical errors of the groups (given in Table V.) show the distance separating the extreme trajectories of the cone, and they are divided into two equal parts by the mean trajectory. Thus to determine the value of the ordinate of the upper trajectory of the cone for any given distance, we must add to the corresponding ordinate of the mean trajectory at that distance, the greatest vertical error of the shot group at the distance at which the ordinate cuts the trajectory. The ordinates of the lower trajectory are similarly found by the subtraction of the greatest vertical error from the ordinate of the mean trajectory.

Position of the Shot Groups above the Ground.

The height of the centre of the shot group of a cone of bullets, above the ground at any distance between the muzzle (or origin of fire) and the point of impact of the bullet, is equal to that of the ordinate of the mean trajectory corresponding to this distance above the line of sight increased by the height of the same point on the line of sight above the ground.

Conditions for the Use of the Rifle in Battle.

Before proceeding further we must first consider the requirements of a battlefield.

"In a battle which is intended to be brought to an issue, one side must act on the offensive, the other on the defensive; the *rôles* may be interchanged, but at any given moment the opposing front lines of the adversaries must be either advancing to the attack, or staying still to defend the position attacked; therefore the distance between the two sides tends to diminish, and it becomes most important that the intervening space between the adversaries should be swept by a storm of bullets. *The ideal of rifle fire in the field is reached, when no bullet in the intervening space between the opponents passes*

over the head of a standing man: that is, does not rise higher than 5 feet 6 inches above the ground.

"Other kinds of actions there are: demonstrative, and retreating; in the former a delaying fire is made use of, and time is given to work out distances; in the latter, the victors being safe, have to raise their sights as the enemy flies before them. But before the action is decided, when the strain is most intense and time most limited, then the fingers must hold the rifle firmly as it may at any moment be required for use with the bayonet; they cannot be loosened to fiddle with a sight, or to adjust it to distances of 50 yards, nor can the eyes be lowered for the purpose, or taken off the enemy, when he is advancing on us, or we on him." Moreover at close ranges under 400 yards, the men are too excited to think of altering their sights. It is no good saying "They must," for all experience shows they will not do so.* The moral excitement of the fight at close ranges is too great to expect the power of control to be kept up with regard to details, though discipline may still allow the men to be carried forward and to attend to the larger questions. For battle requirements, therefore, a single elevation for 400 yards at least is required, which must be made capable of use at shorter ranges by the flatness of the trajectory. How this is to be done will be presently shown.

It is impossible to direct the fire for *all* distances by the employment of one elevation only with special rules for its use,† on account of the confusion that it would create. Consequently as each elevation can have only one range suited to it, the space in front of the firer is divided up for convenience into a certain number of equal zones, as a rule, of 100 yards each in width in England, and 100 mètres‡ abroad, and special graduations are marked on the backsight for the limits of each zone; that is, the graduations given are for ranges 100 yards apart. The height of each of the graduations on the backsights of all rifles is found by experiment, for the mean trajectories of different ranges, and

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* "At the short distances, the rapid firing ought to be executed with a constant elevation, because the men cannot be got to modify their sights when they are wildly excited by the fight, and are, so to say, in the middle of fire."—(General Brialmont).

† Such as, "At —— yards, to fire —— feet above (or below) the point aimed at."

‡ Or 110 yards nearly. A mètre is equal to about $1\frac{1}{10}$ yards nearly, or $1\frac{1}{11}$ yards more accurately.

the distances marked against the graduations, indicate the approximate ranges, corresponding to the elevations they give, at which an object aimed at can be hit. The soldier has then only to estimate at what range the enemy is, and by firing with a suitable elevation he can hope, if the shot is well aimed and placed and is not deviated by the wind, that the enemy will be hit somewhere. It is impossible to say where, but *as the object in war is to put the enemy out of action, the object sought for must be considered as attained if the enemy is struck anywhere.* This is a most important principle to recognise and bear in mind, for it is one of the foundations on which the following pages rest.

Position of the Shot Groups on an Object Situated at a Less Range than that Corresponding to the Sight Used.

In discussing the question of rifle fire across the intervening space between closely opposing forces, a table based on the employment of the 400 yards sight will alone be made use of; for if it serves to prove that the use of this sight is advantageous under the above circumstances, while aiming at a certain point on the objective, then similar tables based on the use of other sights are not needed, as they would only tend to confirm the same fact.

The cone of dispersion of an individual fire has hitherto only been considered with reference to an object situated at the exact distance corresponding to the elevation made use of; it must now, however, be further considered with reference to an object which is situated at a less distance than that of the elevation employed. It is useless to consider the case of an object at a greater distance than that suited to the elevation used, because, under such circumstances, the object would only be hit by ricochets, the effects of which are very uncertain.

In the following remarks it is taken for granted that the line of sight, or the aim, is always directed at some point on the object to be hit (as would be the case in reality), and not at an auxiliary object at a suitable range. It must be pointed out here that if aim is taken at the bottom of an objective (*i.e.*, at its intersection with the ground), and the elevation is not altered, then the results obtained against a moving objective will be the same as if the objective walked or moved along the line of sight, and, consequently, the ordinates of the mean trajectory for the elevation used will give the heights

of the centres of the shot groups on the objective. If any other point, above the ground, on the objective is aimed at, the height of this point must be added to the ordinates of the mean trajectory used, to find the heights of the centres of the shot groups on the objective.

Suppose we are using the elevation for 400 yards and aiming *at the bottom* of an objective (5·50 ft. high) placed at 350 yards from the rifle, then the centre of the group will be placed at 2·14 feet* above the line of sight, that is to say, from the ground when aim is taken at the bottom of the object. If under the same conditions we aim at the centre of the object (at 2·75 feet above the ground), then the centre of the group will be placed at (2·14+2·75) or 4·89 feet above the ground.

The position of the centres of the shot groups is thus given, when aim is taken at the bottom of the object, by the ordinates of the mean trajectory, and when aim is taken at the centre of the object, by these ordinates increased by half the height of the object. Hence this position varies according to the height of the point aimed at, while it is entirely independent of the height of the point of the origin of the fire—*i.e.*, the attitude taken up by the firer.

But although the height of the point struck on the target is independent of the attitude of the firer, yet the resulting dangerous zones are very different. The lower the origin of fire, the greater will be the dangerous zone. This can be seen from the following figure which represents an experiment made with the German Mauser rifle from the kneeling and standing positions; the former position gives a dangerous zone of 50 mètres greater than the latter one at 400 mètres and its ricochets will be more effective. This point should be carefully borne in mind.

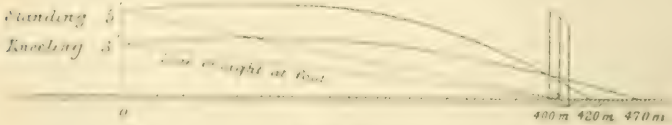

Fig. 7.

Table VI. gives the heights above the ground of the extreme upper and lower trajectories of the cone for 400 yards, on the

* The ordinate at 350 yards for the trajectory of 400 yards, see Appendix II.

supposition that aim is taken with the 400 yards elevation at the bottom and at the middle of an object 5·50 feet in height, placed successively at 400, 350, 300, 250, 200, 150, 100, and 50 yards from the muzzle of the rifle.

The heights of the extreme trajectories are deduced, as already stated, from those of the centres of the groups by the addition or subtraction of the greatest vertical errors of the groups.

TABLE VI.

HEIGHTS OF THE EXTREME TRAJECTORIES ABOVE THE GROUND, SUPPOSED TO BE PARALLEL TO THE LINE OF SIGHT, WHEN AIM IS TAKEN IN ANY POSITION OF THE FIRER, WITH 400 YARDS SIGHT, AT THE FOOT OR CENTRE OF AN OBJECT, $5\frac{1}{2}$ FEET HIGH, PLACED SUCCESSIVELY AT THE DISTANCES GIVEN BELOW.

Distances.	Upper Trajectory.		Lower Trajectory.	
	Bottom of object.	Centre of object.	Bottom of object.	Centre of object.
Yards.	Feet.	Feet.	Feet.	Feet.
50	2·01	4·76	1·79	4·54
100	3·68	6·43	3·22	5·97
150	4·83	7·58	4·25	7·00
200	5·47	8·22	4·67	7·42
250	5·48	8·23	4·44	7·19
300	4·81	7·56	3·43	6·18
350	2·99	5·74	1·29	4·04
400	1·08	3·83	—1·08*	1·67

As has been said, the object to be attained, in order to insure a decisive fire fight at close ranges, is that no bullet in the intervening space should pass over the head of a standing man, and hence it is only necessary to deal with the upper trajectories of the cone of bullets. From the above Table VI., we see that the 400 yards range is the greatest range at which

* The — sign signifies that the bullet, if it had not been stopped by the ground, would be below its surface by the amount indicated. See Fig. 6, p. 59.

the upper trajectory of the Martini-Henry rifle always keeps within the height of a standing man, *and then only when aim is taken at his feet*, and hence the following deduction is at once made from this table, that *when the rifle is directed at the bottom of an object, the intervening space is better swept by the cone of bullets than if it had been directed at the centre of the object.*

In dealing with the Martini-Henry rifle we must not forget that its backsight is graduated for use with a *fine* foresight. But in action men will use a *full* foresight, and if the 400 yards elevation is used in action, even if aim is taken at the foot of an advancing enemy, we must add the errors given in Table II. (p. 21) for the 400 yards range to the above numbers in Table VI., which shows that the bullets would fly well over the heads of the enemy from 150 yards and onwards. This distance is reduced to 50 yards only if aim is taken at the centre of the enemy's bodies. This is probably the cause of the bad shooting in the field of our troops that we have heard so many complaints of. To use the Martini-Henry in the Continental manner for close fighting under 400 yards, it would be necessary to use the 300 yards elevation and let the men use a full foresight. If we add the errors made by using a full foresight with the 300 yards elevation (given in Table II.) to the numbers given in Table VII. (p. 75, a similar table to Table VI. but for the 300 yards range), we will find that the results are very satisfactory for obtaining a very efficacious fire for battle purposes at short ranges, *provided aim be taken at the bottom of the objective.*

From what has been already said, we can fairly state the principal causes of our past frequent failures in the field to produce an effective fire. They are as follows:—

1. Expecting the men to adjust their sights at ranges under 400 yards.
2. The backsight being graduated for a fine sight.
3. Training the men to always direct their rifles at the centre of the objective.

Men in action will not alter their sights under 400 yards, and they will always use a full foresight in the field. These facts should be accepted, and the rules for firing, and the construction of the rifle made to suit them. By aiming at the feet, much longer dangerous zones, grazed by the whole cone, are obtained, and if the 400 yards sight is used with a fine foresight, the bullets will remain under the height of a man up to 400 yards. But if aim is taken at the centre of an

enemy, with the 400 yards elevation, and a full foresight, an upright man is quite safe from about 50 to 375 yards of the muzzle of the rifle. This is the most probable reason for the fact that in the accounts of the fights in the Soudan we *always* read that the enemy were shot down at from 30 to 50 yards from our squares.

It may be objected that men do not aim in battle at close ranges, and that consequently it does not matter whether a fine or full sight is used. But there are many occasions in which men will aim, as one is not always in the middle of a hot fight, and it is on these occasions that a full sight is better than a fine one. Further, when men do not aim, all the reasons given above, and those which are to follow, for aiming low, still hold good in every respect for them to keep their fire low by *directing* their rifles as low down on the enemy as possible.

Table VI. will enable us to see why we should be justified—

(A) In adopting the bottom of the object as the normal point to be aimed at.

(B) In limiting the number of elevations to be used, and their employment to certain ranges and objectives.

(C) In placing 400 yards as the ordinary, and 800 yards as the maximum, limit of individual fire with the Martini-Henry rifle.

(A) Reasons for the selection of the bottom of the object as the normal point to be aimed at.

On the Continent the normal point aimed at is the bottom of the object, and it has been chosen for the following technical and tactical considerations:—

(i) *In aiming at the bottom of an object, the line of sight inclines more and more towards the ground as the enemy gets nearer.* When aim is taken at the middle of the object, this result is not obtained in the kneeling and lying down positions. In fact the line of sight is horizontal, if the firer is kneeling (because the height of the origin is 2·67 feet like that of the point aimed at), while, when the firer is lying down, it rises as the objective approaches (the origin of fire being only 0·89 feet above the ground while the centre of the object is 2·67 feet). *Moreover, the position of the shot-group on the object, when the foot of it is directly aimed at, does not depend on the height of the origin of fire*, as can be seen from Table VI.

(ii) *Aiming at the foot of an object gives a more advantageous position to the shot-groups, and makes the zones grazed by the whole cone to be longer.* In Table VI. we see that the upper trajectory of the cone for 400 yards does not rise so high as 5·50 feet when aim is taken at the foot of a standing man, (its real height being 5·48 feet), whilst it rises as high as 8·23 feet when aim is taken at his centre. In the first case, the *whole* cone of bullets remains within the height of a man from the muzzle up to 400 yards, while in the second case, this only occurs from about 350 to 400 yards. Similarly for any other range it will be found that a greater dangerous zone is obtained when aim is taken at the feet, than when it is taken at the centre of the object. It must be particularly pointed out here, that in finding the conditions to obtain *an efficacious individual fire*, we must only deal with the zones grazed by the "*whole* cone of dispersion," that is, with the central part C E of the cone in Fig. 6, p. 59. When this central part vanishes, as we see from Plate I. that it does at about the 800 yards range, no efficacious individual fire can be expected, even when the range is exactly known, and neither also can it be, when the ranges have to be guessed, if the length of this central part is less than the error to be expected in appreciating the range. When this central part vanishes the fire ceases to be grazing, and becomes a dropping one.

(iii) *The ricochets from all the lower half of the cone are effective.* If the correct elevation is used and the aim is taken at its foot, the object fired at is placed at the point of fall of the mean trajectory, that is, at the centre of the beaten surface in advance of the points of impact with the ground of the lower half of the cone. But it might be said that in this case only one half the shot group will hit the mark. In the report of the experimental firing at Dungeness, it is stated that "the bulk of ricochet hits are effective"; and that the mean rise of a bullet is twice that of its drop (see p. 14). Accepting these data, then from Table VI., we see that when aim is taken with the 400 yards elevation at the foot of a target at 400 yards, the lower trajectory will theoretically pass 1·08 feet below it, but the bullets will really strike the ground in front of the target, and strike it $2 \times 1{\cdot}08$ or 2·16 feet from the ground. Thus, it may be noticed that the height at which the shot, forming the lowest trajectory, ricochets into the target, always coincides with twice the greatest vertical error of the shot at the distance fired at, and

hence all the ricocheting bullets, under the supposed conditions, will strike a target of the height of a man up to the 800 yards range.

(iv) *When aim is taken at the middle of the object, if a shot be fired with a little too much elevation, or if too much of the foresight is used, the bullet may pass above the head of a standing man; this inconvenience is not so much felt when aim is taken at the bottom of the object.* This can be seen by comparing, in Table VI., the heights of the upper trajectory of the cone above the ground in each of the two cases of aiming with the 400 yards elevation, at the bottom and at the centre of objects placed successively at 400, 350, 300 yards, &c. As men in action always use a full foresight, the backsight should be graduated for its use so as to avoid this error as much as possible, and if aim is taken always at the foot of the object, the theoretical evil of a less accurate fire resulting from the use of a full foresight is almost entirely avoided.

(v) *The foresight, which covers half the height of an upright man when the latter is at a distance of 200 yards, is not so likely to hide the objective from view.* Thus, at ranges over 200 yards, the least upward movement made by the barrel will, if the centre of a man is aimed at, entirely hide the objective from the view of the firer. This only occurs at greater distances than 400 yards, if the bottom of the object is aimed at.

(vi) *Tactically it is more advantageous to aim at the bottom of the object than at the centre.* "If the smoke hides the objective it is impossible to aim at its centre, while on the contrary it is very easy to distinguish and aim at a mark taken on the line of separation which exists between the cloud of smoke and the ground, this line being clearly defined in the field. On the other hand, if the adversary, while advancing, disappears behind some artificial shelter, or is lost to sight in a depression in the ground, aim can still be taken at the entrenchment, or at the mark on the ground previously selected, and the bullets thus fired will have a good chance of being well directed. Besides, is not the soldier in the heat of action always tempted to take too full a sight? In making him aim at the bottom of the object, a compensating influence is brought to bear on this fault, which is so common amongst men in the field. Further, by thus aiming at the bottom of the objective the cone is lowered, and the enemy as he advances, plunges himself more deeply into the rain of bullets, instead of getting out of it, as he would, if aim had been taken in the centre of the object fired at."

With reference to *the point that should be aimed at* on the object to be hit, the Germans very sensibly say that men should as a rule be accustomed to aim at the bottom of a target, because *in action*, even at the longer ranges, all that a man often has to fire at is a bank of smoke, and the bottom of this cloud against the ground forms a definite line to aim at, while it would be hard to know at what other point of the moving cloud to tell the men to fire; at the longer ranges such nicety of aiming at any exact spot on a man is unnecessary, from the inaccuracy of individual fire,* and because the exact range and the effects of wind and other causes of error are not known at all, so that the firing must be somewhat chance work. Thus all that can be done is to aim at some definite mark as near as possible to the position of the object to be hit. The mere fact, that no two bullets, fired by the same man, will hit in the same place, shows the uselessness of aiming at long ranges at any particular spot in individual firing.

With regard to the closer ranges in action there is still an advantage in aiming at the bottom of the object to be hit. As a rule men in action fire much too high, especially the nearer the enemy is, and their excitement greater, and such a plan will tend to keep the bullets down. Even if a bullet does strike short, the ricochet will be effective, while if it goes too high it will pass right away. The German regulations say: "It is required to hit the object somewhere rather than to hit it in one particular point, and therefore it is better to choose a point low down to aim at than a higher one, and consequently the foot of the object will be aimed at as a rule with a suitable elevation of sight." The exception, in the German regulations to this rule, is when the object is less than 270 mètres off (the range of the lowest sight on the Mauser rifle) and it is under half the height of a man, in which case, the aim is to be taken at a distance of one or two apparent "heads" under the object according to the range.

The French regulations also say: "In action it is best as a rule to aim at the foot of the object. The line of intersection of the objects with the ground generally furnishes more distinct and apparent points to aim at than the centre of the object."

The Italian regulations say: "Aiming at the lowest edge of an objective has the following advantages:—(1) The line

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* Besides, the accuracy of a properly executed long range fire is not dependent on the accuracy of individual fire, as will be explained in Part II. The conditions of long and short range fire are, in fact, entirely different.

of intersection of the object with the ground is always well defined and distinct, and, therefore, more easy to aim at than any central point, which is generally vague and undetermined, and easily lost sight of when the enemy is partly covered with the foresight. (2) In battle the enemy is often hidden by smoke, and, in this case, aiming at the centre is impossible, whilst it is always possible to aim at the line of demarcation of the smoke with the ground. (3) Aim is to be taken at the foot of the object in every case without exception, even when firing at small targets, such as men lying down, at very short ranges, because if aim is taken at the centre it will not be possible to hit these objects, from the cone of bullets passing over them. (4) By aiming at the feet, the flatness of the trajectory is better utilized, in fact, the depths of ground beaten by the whole cone, and in which any forward movement of the enemy does not necessitate any change of elevation, are greater when aim is taken at the feet than when taken at the centre. . . To accustom the soldier, in peace time, to the most favourable system of aiming in war time aim will always be taken at the foot, even at target practice."

The American regulations say :—"In order that the effect of the ricochet may not be lost, care should be taken not to over-estimate the distance, and to aim at the feet of the enemy. This selection of a point of aim, is, in fact (except when the enemy is within short range), especially advantageous; as, when it is employed, a greater number of the bullets in the shot-group will usually prove effective; and, as moreover the line of separation which exists between the cloud of smoke and the ground offers the best defined object, and also the error so common in the heat of action of taking too full a sight is neutralized."

At the very shortest ranges, when rapid fire takes place, the whole front is soon covered with a cloud of smoke, which hides the enemy from view; the only rule then is to hold the rifle parallel to the ground and fire direct to the front.

Sometimes, however, an aimed individual fire at single objects may be made use of, especially in savage warfare. With the English rifle, which is sighted for as short a range as 100 yards, aim may be taken at the centre of a small object at the shorter ranges so as to get shot group higher on it, though if the object is very small, this is often better done by aiming at its intersection with the ground, from its being better seen, and not hid by the foresight. If the range is unknown it is also best to aim low (for the same reason that a too low

elevation is preferable to a high one), because the ricochet may hit, while a bullet that passes too high passes right away harmless. As the rifle is sighted for 100 yards, aim at 50 yards need only be taken 4 inches, and at 25 or 75 yards 2 inches, under the point that would be aimed at if the object were 100 yards off. With regard to standing men, we can still use the 400 yards elevation, if aim is taken at the feet, for the shortest ranges, because in Table VI., we see that at 100 yards the bullet would, in this case, strike about 3½ feet above the ground; at 50 yards it would theoretically be better to aim at the knee, when using the 400 yards elevation, but experience shows that the action would have been decided before this range was reached, and that at such close ranges men fire very high.

At the longer ranges, from the uncertainty of individual fire, it is immaterial whether the centre or the bottom of the object is aimed at, but as at the shorter ranges, however, the men should always aim *in action* at the bottom of objects to be hit, for the reasons already given, *they should therefore be always accustomed to use this point, by its being made the normal point to be aimed at at all times.* If the range is exactly known, then, while aiming at the foot of the object, a slightly higher elevation may be used, depending on the height of the object, so as to raise the shot group on it.

When aim is taken at the bottom of an object, the mean trajectory of the cone and the line of sight intersect at the range corresponding to the elevation used; thus the upper half only of the cone strikes the object at that distance whilst the other half falls short and can only strike after ricocheting. But on the field of battle, we must always remember that, as neither the objectives nor the firers are stationary, the distances diminish without ceasing, so that by aiming at the bottom of the object, the enemy, as he advances, plunges more deeply into the rain of bullets or efficacious zone, instead of getting out of it, as he would if aim had been taken at the centre of the object fired at. Besides, if the enemy is retreating, a sight for 50 yards over the estimated distance can be used.

To sum up, aim for individual firing in action should always be directed at the foot of the object,* for the following reasons:—

* Aiming at the foot of an object is not a new procedure in England; Oliver Cromwell used to order his men to aim at the shoe-buckles of their opponents.

(*a*) That the intervening space swept by the cone of bullets is lengthened.

(*b*) That the evil arising from the use of a fuller sight than the backsight is graduated for is mitigated.

(*c*) That the ricochets of the lower half of the cones of dispersion are better utilized.

(*d*) That tactically it is advantageous.

Though to aim at the foot of an object should be the normal rule to accustom men always to do so, yet it should be understood that if the object is known to be exactly at the range corresponding to the elevation used, aim may be taken a little higher to raise the shot group on the object, or what is better still, in order never to let the men forget to aim at the feet, to make them use a greater elevation while aiming at the bottom of the object. Custom is a prime factor in war, and becomes a second nature, even in moments of the greatest moral strain.

(B) Limits for the Employment of Different Elevations in Individual Fire.

For moral reasons, as we have pointed out, soldiers will not adjust their sights at the critical moment of combat, (*i.e.* under 400 yards), either when they are advancing rapidly on an enemy or he on them. The maximum distance which separates the two adversaries at this stage of an action may be assumed to be about 400 yards, and therefore one fixed sight if possible, is best for ranges under this distance, as the men will not be got to keep on adjusting their sights as the enemy gets nearer. Practically however, from want of perfection in the existing rifles, it is found that two such sights are required to fulfil the required conditions satisfactorily. In the German rifle, these two are a fixed sight for 270 mètres (300 yards,) and an easily raised flap sight for 350 mètres (400 yards nearly.)

In Table VI., we see that the zone grazed by the whole cone, with regard to an upright man, extends without a break from the muzzle to 400 yards, when aim is taken at the bottom of the objective, because the upper trajectory of the cone does not pass higher than 5·48 feet above the ground, while the height of a man is 5·50 feet. Thus from the flatness of the trajectory, the elevation for 400 yards can be used for firing at any object the height of a man up to 400 yards, especially if he is

advancing.* The accuracy of the rifle also allows of this, for the width of the shot group at 400 yards is only 1·72 feet (Table V.) or rather wider than the vulnerable part of the body of one man, but less than his total width, and the depth of the shot group is only 2·16 feet. Thus, seeing that the zone of the 400 yards elevation, grazed by the whole cone, when aim is taken at the feet, is not less than 400 yards, the enemy will always be hit if he is within that distance, even if an error of judgment in estimating the distance has been made. If the enemy is missed by the first shot, he will be hit by one of the following ones, especially as in order to capture the required position, he must advance or plunge more and more into the efficacious zone of the defender's bullets.

Table VI. shows that the elevation of the upper trajectory above the ground with the 400 yards elevation, is 2·99 feet, at 350 yards and 4·81 feet at 300 yards; hence an objective half the height of a man (3·67 feet, see p. 58,) will be struck when aim is taken at its foot by the whole cone at about 325 yards, but not so at 300 yards. Thus the limits of the zone grazed by all the cone, with the 400 yards elevation, for an object half the height of a man, lies between 325 to 400 yards. The accuracy of the rifle also coincides with this, as the total vertical error is 2·16 feet; and hence the 400 yards sight can be used between 325 and 400 yards, for objects as wide as a man (1·33 feet), and of a height equal to half the height of a man, *if the range is known.*

It only remains further to see if the depth of the grazed zone for an object half the height of a man remains the same when allowance is made for the inevitable error in judging distances. The mean error of judging distances is about $\frac{1}{8}$th of the estimated distance†, or about 50 yards in the case under

* That is if a fine foresight is used with the Martini-Henry Rifle. But as was shown on p. 66, it would be necessary to use the 300 yards elevation, with a full foresight, in action, to obtain the best results. This, it will be supposed, will be fully borne in mind with reference to the following pages.

† From numerous experiments made in Germany it has been found that the average errors made in judging distances up to 1,200 yards is from $\frac{1}{6}$th to $\frac{1}{7}$th the estimated distance. The Russians say $\frac{1}{10}$th the range is the average error. The German rules for firing however, allow for an error of $\frac{1}{8}$th the range, which will be the error used throughout this book. But twice this error should be allowed if the object should be on either side of the range under consideration, as the error may be too great or too little. However, in the above case, the object is supposed to be on one side only of the range considered, and so only the actual error is used.

consideration. Thus, if the real distance is 350 yards, and a sight of 400 yards is used, the object will still be struck, since the zone grazed by all the cone 3·67 feet from the ground, extends from 325 to 400 yards, or for 75 yards.

Table VII. is a similar one to Table VI., but is worked out for the 300 yards sight.

TABLE VII.

Distances.	Upper Trajectory.		Lower Trajectory.	
	Bottom of Object.	Centre of Object.	Bottom of Object.	Centre of Object.
Yards.	Feet.	Feet.	Feet.	Feet.
50	1·42	4·09	1·20	2·87
100	2·45	5·12	1·99	4·66
150	2·92	5·59	2·34	5·01
200	2·86	5·53	2·06	4·73
250	2·11	4·78	1·07	3·74
300	0·69	3·36	—0·69	1·98

From this table we see that if the aim be directed on the foot of the object, the upper trajectory is everywhere under the height of an object equal to half the height of a man (or 3·67 feet) as its greatest height is 2·92 feet. Hence, for the Martini-Henry rifle, all that is actually required for war purposes as regards sights for short ranges, when aim is taken at the foot of the object, is a fixed sight for 300 yards, and a flap sight for 400 yards, and the usual leaf sight for longer ranges*; but the backsight ought to be graduated for a full foresight which men will always use in action.

* The three sights of the Mauser rifle are :—

1. The fixed sight for 270 mètres.
2. The flap sight for 350 mètres.
3. The leaf sight for 400 mètres and upwards.

The flap sight is the true fighting sight of the rifle; the fixed sight is rather a supplementary sight, to be employed against objects half the height of a man, or the height of a kneeling man and less; while the leaf sight for 400 mètres is the special sight against cavalry.

A mètre is $1\frac{1}{10}$ yards nearly.

If such a fixed sight for 300 yards is adopted, then simple special rules would have to be given for its use at shorter ranges, when aim is taken at the bottom of the object; such as "At — yards, aim to be taken one (or two) apparent heads' lengths below the object to be hit."* But the cases where small objects have to be fired at at such short ranges rarely occur in war, and never in any serious circumstances as in an action. Hence, such rules will have a very limited application.

The conclusion now arrived at is, that with the Martini-Henry rifle, the two elevations of 300 and 400 yards, combined with aiming at the foot of the mark, are sufficient to keep all the ground up to at least 400 yards well under fire if the backsight is graduated for use with a full foresight. If a fine foresight is retained, then for each of these distances, the elevation for 100 yards less must be used.

The principle of using a single elevation for different distances has now been recognised in England, but the principle has been badly applied. Thus in the Musketry Regulations (1887) the 200 yards elevation is to be used in the attack and defence practices; but the men are ordered to aim at the head of the enemy at 265 yards in the attack, or at 320 yards in the defence, and lower down as the distance lessens, until at 150 yards in the attack, or 100 yards in the defence, from the enemy, the feet are to be aimed at. From the foregoing pages it will be seen that this is quite unnecessary, as aiming at the feet throughout is ample. Moreover, in action, under 300 yards, men will not think of the range (and much less will they calculate it to 5 yards as in 265 yards!), and at what part of the enemy's body they should aim in consequence, even leaving out of consideration the fact that the enemy will be upright at one moment and kneeling or lying down the next. With all the information we now have of the wild and high firing of our troops in our small wars, anything tending to make men aim high is greatly to be deprecated, and this is a strong reason for teaching men to *always* aim at the feet of the enemy. 300 yards is a very close range to expect soldiers to be under sufficient control to adjust their sights. The range of 400 yards chosen in the

* A head's length is about 10 inches. The head of a visible enemy would be always seen, and gives a good guide to judge by. A distance of more than two "heads" below an object would never be required, as a man lying down is 1.50 feet high, which, added to 20 inches, gives a total height of 3.17 feet, which is more than the greatest height of the upper trajectory of the 300 yards sight when aimed at the lowest part seen of a man lying down.

foregoing pages is a better distance, while the trajectory at that range is under the height of a man above the line of sight.

The above considerations afford a strong argument in favour of flattening the trajectory at short ranges, and increasing the accuracy of the rifle, in order to cover as much ground as possible with one fixed sight. The importance of this has been thoroughly realized abroad, for Germany, France, and Russia are all meditating the adoption of a rifle with a 0·37 inch calibre, both for the above purpose, and also in order to meet the probable introduction of a magazine rifle, which requires a small cartridge. With this proposed rifle of 0·37 inch calibre, a trajectory, whose maximum height is under the height of a man, is obtained up to 600 yards, but in the English Service it has been decided to consider long range fire more than short range fire, and hence it has been laid down that our future rifle is to be a 0·400 inch bore, which gives rather a lower trajectory than the proposed future Continental rifle at the longer ranges, where flatness of trajectory is of little use, while it gives a higher trajectory at the shorter ranges, where every inch of flatness is required.

Since the above was first written, the principles of using only two sights for the shorter ranges has been adopted for the new Enfield-Martini rifle. The sights chosen are, a fixed sight for 100 yards and a flap sight for 300 yards. When aim is taken by an upright man with the 100 yards elevation at a point 5 feet high, *i.e.*, when the line of sight is horizontal, the bullet will range 350 yards; and with the 300 yards elevation, under the same conditions, it will range 450 yards. This is doubtless a better system than the existing one, but it does not give the best elevations for battle requirements. These can only be obtained by accepting the principle of aiming at the feet, and by an inspection of the trajectory tables for different ranges, together with the shot groups at the same ranges, as has been done above for the Martini-Henry rifle.

The Americans, who are our great rivals in accurate individual fire at targets, are no believers in being able to obtain such a fire in the trying moments of an action, and they fully accept the fact that men will not alter their sights at the shorter ranges. Their regulations say:—"When the enemy is only at a moderate distance (500 or 600 yards), the flatness of the trajectory, and, if the ground is favourable, the added effect of the ricochet, render the slight errors which may be made in the estimation of the range of but little

importance. When he approaches within the continuous dangerous space of the rifle, no further changes in the adjustment of the sight should be made as his distance varies."

With regard to the necessary rules for aiming when a rifle has only two sights for all the shorter ranges, we may quote the German musketry regulations as an example. The rules for aiming given there, after stating that the aim may under certain circumstances be directed at the head, or the centre, or the feet of an enemy, are as follows:—

"As a general rule the foot of the object should be aimed at.

"At ranges which exactly correspond to the elevation used, or which are rather greater than this, the centre of the object may be aimed at.

"Against objects half the height of a man and under, aim must be taken at one or two 'heads' (10 to 20 inches) below the object, when the fixed sight is used between 40 and 230 mètres or the flap sight is used between 270 and 330 mètres.*

"These rules are not absolute; different circumstances can modify them.

"In firing at very short ranges and on objects of only small dimensions, the soldier next the firer can watch his shot, and tell him of any necessary correction to be made in his aim.

"In a fire, where several elevations are simultaneously employed (see Chap. IX.), aim is always to be taken at the feet."

The German rules for the employment of the three different sights on the Mauser rifle, in individual firing are as follows:—
"The fixed sight can be used for all ranges between 0 and 270 mètres: the flap sight between 270 and 350 mètres. The flap sight is the best sight for use against cavalry at short ranges (see p. 383). From 400 mètres and onwards the elevation corresponding to 50 mètres under the range, is to be used. Example: the elevation for 400 mètres to be used at 450 mètres." (See p. 180).

The French regulations, after laying down that all aiming is to be at the foot of the object, give the following rules for the employment of the sights:

"The different elevations can be utilized in the following manner—

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* See footnote on p. 75. From 0 to 40 mètres and from 230 to 270 mètres, aim is taken with the fixed sight at the foot of the object Similarly with the flap sight between 330 and 350 mètres.

"The 200 mètres elevation*: between 0 and 200 mètres against men laying down, kneeling, or standing.

"The 300 mètres elevation: between 0 and 300 mètres against men kneeling or standing.

"The 350 mètres elevation: between 0 and 350 mètres against men standing.

"The 400 mètres elevation: between 0 and 450 mètres against mounted men.

"The employment of the other elevations necessitates a greater accuracy in estimating the distance of the object."

(C) Limits for the Employment of Individual Fire.

Individual fire is the fire of individual men when left to their own initiative; that is to say, it is the fire of men freed from all control, and therefore free to choose their object, their elevation, and to regulate their own consumption of ammunition, while *collective fire* is the regulated, if not simultaneous action of a number of rifles against a named objective, in obedience to the will of a single man. In the first case, the fire is left to the initiative of the individual men, whence its name of individual fire, and in the second case, it is placed in the hands of a leader.

Now it is very important to remember that there are two completely different conditions under which individual fire can be used:—

1. Against a mass of enemies in a battle, and
2. Against a single enemy, or a small group of men when accidentally met with.

With this second condition only it is intended to deal here at present. For want of recognition of these two cases much misunderstanding has arisen in defining the limiting ranges of individual fire, when directed against objectives of various sizes, for the soldier would naturally say, "If it is laid down that I am not to fire at a kneeling man, say beyond 300 yards, then I must never do so if he is at ranges beyond that." On the face of it we see that such a conclusion would be absurd for battle requirements, where circumstances are quite different to the second case given above. In action, in front of the soldier there is a practically continuous line of enemies, behind which, at various intervals, come other lines and other bodies of men. If he fires at a particular man in the front line, whatever his attitude (though usually it is only a bank of

* The lowest elevation on the French rifle.

smoke a soldier has to aim at), and if he misses the particular man aimed at, he may hit another at either side of him, or one in the lines or bodies of troops behind, while the noise of his firing cheers himself that of his passing shot tends to instil fear into the enemy.

Hence in action the following rules for the limits of individual fire cannot apply in the full. In Part II. we will more thoroughly study the question of fire tactics in battle. At present we must remember that we are not dealing with such tactics.

Accepting the above definition of individual fire, it becomes necessary to fix some limits within which this fire may be employed, or else a serious waste of ammunition would take place, from the area of the shot groups being too large as compared with that of the objectives fired at. The accuracy and flatness of trajectory of a rifle, the skilfulness of the men in firing, and the errors made in judging distances, lay down precise limits for the employment of individual fire under the supposed conditions.

These limits may be theoretical or practical; the first case supposes a very good shot making no mistakes and knowing the exact distance; the second assumes that the two factors of errors in aiming and errors in estimating distances, will always militate in the field against attaining the theoretical result.

First, with regard to the *theoretical* limit for the employment of individual fire in the field, leaving out of consideration any error on the part of the firer in directing his rifle, let us see what the limit for the use of individual fire should be when the range and elevation for it are exactly known. In this case the centre of the shot groups coincides with the position of the objective, and hence the *depth of the ground grazed by the whole cone* does not affect the question, *provided such a zone exists*. In Plate I. we see that 800 yards is the maximum range at which there is such a zone grazed on the whole cone. Further, at 800 yards the height of the shot group being 5·16 feet (see Table V.), or nearly the height of a man, and its width 3·96 feet, a good firer will put 89 per cent. of his shots in an objective of a group of 3 men, but beyond 800 yards the depth of the groups are more than 5·50 feet, and even a good firer cannot put a definite proportion of his shots into a line of infantry; he only fires by chance and trusts to luck. Also we see that at 800 yards the firer must make no error in directing his rifle, as the shot group, even when well placed, is only just within the height of a man.

Now, with regard to the *practical* limit for the employment of individual fire in the field. As said above, two factors govern it; errors in aiming, and errors in judging distance.

At 500 yards the width of the shot group is only about 2·14 feet, and its depth 2·66 feet. Thus, at this distance a *good firer using the proper elevation*, and firing on a group of two men, 3·50 feet wide) will put 92 p.c. (deducting abnormal shots) into the objective. But this good shot has to judge the distance, and in doing so he may commit an error of $\frac{500}{8}$ or 62 yards, too much or too little. The question now is, whether this total limit of error of 124 yards is compensated for by the depth of the ground grazed by all the cone. In Plate I. will be found the depths of these zones for different ranges.

From this plate we see that with a 500 yards elevation the zone grazed by the whole cone extends for only 51 yards, which, therefore, does not even nearly compensate for the above possible error in judging the distance, even supposing that the centre of the shot group is not displaced by abnormal or accidental influences, which, however, is usually the case in reality. A similar calculation will show that 400 yards is the greatest practical limit for individual firing, and from the construction of the backsight of the Martini-Henry rifle, the elevation for 400 yards affords a practical guide for the limit of such a fire.

Hitherto we have considered the firer to be skilful enough to prevent his rifle moving while firing, but suppose a less skilful firer to make an angular error in aiming of about 10 minutes too high.*

An angular error, in the position of the line of sight, of 10 minutes of arc will cause a vertical error in the position of this line of 0·873 feet for every 100 yards, and so the vertical error will be 4·36 feet at 500 yards and 6·98 feet at 800 yards. If we add the error of 4·36 feet, of the line of sight for 500 yards, to the depths of the shot groups at the same distance we get 5·69 feet and hence a firer who makes an error of 10 minutes too high in aiming will not be able to hit, at this distance, a group of men in line, but he can at 450 yards.

At 800 yards the depth of the shot group being 5·16 feet or nearly equal to the height of a man, a firer must not make even the least error, and hence 800 yards is the theoretical

* This error must not be confounded with taking too much foresight. It is an error to be allowed for besides this latter error, and is due to unsteadiness in holding the rifle to the shoulder.

limit, while 450, or, better still, 400 yards, from the construction of the backsight, is the practical limit for individual fire.

It may be remarked here that though the effects of an angular error in aiming increases with the distance when fired at a vertical target, yet this is not the case if the bullets are received on a horizontal surface, or on a series of targets placed in column. In fact the error in range caused by a given angular error in aiming decreases instead of increases with the distance.

For example, the angle of elevation for 100 yards is 0° 10′ and for 200 yards it is 0° 21′ or a difference of 11′ for a difference in range of 100 yards or 1′ for about every 9 yards.

The angle of elevation for 400 yards is 0° 49′ and for 500 yards it is 1° 9′ or a difference of 20′ for a difference in range of 100 yards, or 1′ for about every 5 yards.

The angle of elevation for 900 yards is 2° 28′ and for 1,000 yards it is 2° 50″ or a difference of 22′ in a range of 100 yards, or 1′ for about every 4·5 yards.

This explains why the length of the front or beaten zones shewn in Plate I. vary very slowly after 500 yards.

Résumé.

If we compare the heights of the objectives met with in war with the depth of the shot groups beyond 400 yards, and if we consider the errors caused by any angular deviation in the aiming, we are forced to the conclusion that even a good shot has very little chance at greater ranges of putting a definite proportion of his hits into an objective the height of a man.

On the other hand a cone, capable of causing an efficacious dangerous zone, cannot be obtained unless at least 50 cartridges are fired. A single man cannot afford to expend such a great amount of ammunition on a single objective, especially if he cannot watch the results of his shots, and even if he attempted to do so, he would not have time to expend such a great proportion of his supply sufficiently rapidly or in identical conditions.

Further, it is necessary that this depth of zone should be at least equal to one-fourth the range, in order to neutralize the effect of a probable wrong estimation of the distance, but this proportion of the zone, grazed by the whole cone, to the range, only exists when the range is under 400 yards. But

this error of estimating the distance can only be absolutely corrected when the trajectory is under the height of a man, which occurs only for ranges under 400 yards, and hence the 400 yards range should be considered as the maximum limit for individual fire in the field. The construction of the present backsight of the Martini-Henry rifle also favours this conclusion for practical purposes.

Thus, when the distances are estimated it is useless to fire over 400 yards, and when the distances are exactly known, over 800 yards, *and then only at suitable objectives*, and as these distances have been worked out for a good marksman they may be taken as the extreme ones and should never be exceeded.

The Germans say, from the preceding arguments, that nothing is to be expected beyond 400 or 800 yards from the fire of single men, and that at such distances, the skill of the firer cannot counterbalance the unfavourable influences independent of his action.* Thus, instead of making 8 skilful men, free to choose their own objectives, fire 60 cartridges in 2 minutes on 8 or 10 objectives perhaps, they prefer at greater ranges than the above, to resort to an intermittent collective fire, that is to say to concentrate simultaneously the fire from 60 men, expending an equal number of bullets, on the same objective with the same elevation, and then to make a pause in the fire. The Germans consider individual fire over the ranges given above, that is to say, a fire, the conduct of which is left to the individual men, to be a true waste of ammunition.

The Germans particularly insist on the fact that in war the object and the firer are not stationary, but are subject to movement at the end of very short intervals of time; hence the impossibility of a soldier, placed at distances at which the zone grazed by all the cone cannot be considered from being so small, being able to expend a sufficient number of projectiles in

* Two French writers have made the following calculations as to the number of rounds required by an average shot at different ranges to put an isolate standing enemy *hors de combat*. Either estimate shows the great increase of ammunition required as the range increases, to effect a given result.

Range, in mètres	200	300	400	500	600
Number of rounds ..	13	16	30	47	112
	—	5 to 6	10 to 12	14 to 16	30 to 34

identical conditions, that is to say, of firing at the same range and from the same place, a series of bullets on the same object, all of which are indispensable conditions to be fulfilled, in order to obtain an efficacious dangerous zone.* The soldier, on the contrary, fires at first on one object, then on another, and it is not possible for the trajectories of projectiles, so fired in different directions, to form a cone of any density.†

Of course in outpost, or in advance or rear guard work, individual fire can be used in certain circumstances at any distance, but in this case the fire is mainly made use of as a signal or for intimidation, and the firer does not expect any other result.

Thus, at 400 yards, the zone of *individual fire*, or of fire which does not rise above the height of a man, or of fire based on the extent of the zones grazed by the whole cone, terminates, and the zone of *collective fire*, or of fire based on the depth of the efficacious beaten ground, begins. This collective fire, in which the control should be invariably placed in the hands of the leaders, and not abandoned to individual inclination, is conducted on the Continent according to principles which will be pointed out in Part II.

With regard to the limits for employing individual fire against different objectives, the German regulations lay down for the Mauser rifle that—

"A good shot can be expected to hit

"At 200 mètres, an object of less height than half the height of a man.

"At 250 mètres, an object of half the height and of the full width of a man.

"At 350 mètres, an object of half the height, but of greater width than a man.

"At 450 mètres, an object of the height of a man, or of an isolated mounted man.

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* The fire of crack shots on an enemy in line at 800 yards, at which the zone grazed is two yards deep, and the shot group 6 feet high, would only be justified, according to German ideas, in siege warfare, when the position of the firer and the objective are more fixed than in the open field. Some say the distances can be measured off a map, but no maps are usually available in the field that would allow of distances being measured with such great accuracy.

† It is necessary that a sufficient number of bullets should be fired *under the same conditions* to obtain the hits, for the group to merit the name of a shot group.

"When the range is exactly known, the last two distances may be respectively increased to 400 and 600 mètres. Beyond these limits, certainty and rapidity of effect must be sought for in the simultaneous employment of a great number of rifles directed on the same objective." (See Chap. IX.)

The French regulations for the Gras rifle lay down the following limits:—

"The limits for the employment of fire depend on the accuracy of the arm, on the knowledge of the distance, on the dimensions of the object, the skill of the firer, and on the form of the ground.

"In war, the moral state of the troops who fire and the quantity of ammunition at their disposal must also be considered. Therefore, limits for the employment of fire cannot be fixed in an absolute manner.

"Nevertheless, the results of numerous experiments, allows of some general rules being laid down. The distances at which there is a chance of hitting without an exaggerated consumption of ammunition are limited as follows:—

"At 220 yards, for a sheltered or lying down man.

"At 330 yards, for a kneeling man.

"At 440 yards, for a standing man.

"At 500 yards, for a single mounted man.

"At 550 yards, on an isolated squad, lying down.

"The way that the form of the ground influences these distances, is that the folds in it, or cover on it, may allow of an enemy to get within shorter ranges than those laid down."

The American and English regulations have almost exactly followed the French ones.

From the foregoing pages, we see that the limits for the use of the different elevations are governed by very different considerations in England and on the Continent.

In our Army the limits are fixed by considerations deduced (1) from the heights of the *mean* trajectory above a horizontal line of sight when directed on the centre of a standing man and (2) from the extents of the theoretical dangerous zones corresponding to an objective 5½ feet in height (*i.e.*, the height of a man).* Abroad, however, as we have seen the limits are based (1) on the heights of the *upper* trajectory of the cone of bullets above a supposed horizontal ground, (2) on the depths of the grazed zones,† corresponding

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* See dimensions of objects given on p. 58.

† A grazed zone is the distance in which the bullet remains under the height of the object to be hit, during its flight.

to the height of a standing, a kneeling, or a lying man, (3) on the whole cone of dispersion of the bullets, and (4) on the connection between the widths of the groupings of bullets at each range and the most usual objectives in war. In other words, abroad, the flatness of the trajectory, the ordinates of the extreme trajectories, and the accuracy of the rifle are considered together, — this accuracy being measured by the dimensions of the surfaces in which the rifle can group its shots at each distance, after deducting a certain percentage for abnormal hits which varies with the distance.

CHAPTER VI.

REMARKS ON THE EFFICACY OF INDIVIDUAL FIRE AT DIFFERENT RANGES.

Experiments with modern military rifles *against targets*, show that at 100 yards the accuracy is uniform for all objects; at 200 yards the difference begins to be felt according to the size of the target. At 300 and 400 yards the difference is still more marked.

After 500 yards against a kneeling man, and after 600 yards against a standing man, there is scarcely any chance of hitting him.

After 500 yards the percentage rapidly diminishes for kneeling formations, and after 600 yards for standing formations.

Experience in war, however, shows that when men are opposed to a heavy fire, then at the shortest ranges, where the danger is greatest, the accuracy of the fire, contrary to peace experiments, is worst of all. Consequently, peace experiments at short ranges can rarely give us any data for war purposes. At the short ranges, it is discipline and control that tell chiefly, by enabling the men to carry out orders.

As regards immunity from losses, experiments and experience show that the lying down formations are far superior to the kneeling ones, and still more so to the standing ones. Cavalry, consequently, suffer more from their greater height and surface exposed.

The results, usually obtained in peace experiments, are the greatest ones that can be got in exceptional cases with a very good shot, good arms and ammunition, the range being known, and the result of the shots signalled back; besides which, the mean trajectory is supposed to pass through the point aimed at, which however is rarely the case, and the effect of wind is also neglected. This shows the uncertainty of getting anything like the above percentages in ordinary circumstances, and shows in the plainest characters, the extreme uncertainty of individual fire.

The influence of wind depends on its intensity, direction, and on the range or time it has to act on the bullet. With a

strong side wind at long ranges, such as 1,000 yards, the deviation may be 50 or more feet, and with such a wind, accurate firing is very difficult, from the rifle being so shaken by it (unless it can be rested on anything). To hit the object, we must aim a certain amount (which has to be judged at the firer's discretion), to the side of the object in the direction of the wind. Such a wind must considerably reduce the chances of hitting, because a definite point is not usually to be found outside the target to aim at each time, so that the aim may vary for every shot, because a man cannot tell if he has judged the amount correctly.

In examining the results of experiments, we shall find that the percentages of hits diminish progressively with the distance. The progressive diminution of the value of these percentages is caused by the relative proportions of the surface of the target, and of the amount of the errors in shooting, and, consequently, the percentages obtained on large targets diminish less rapidly, as the range increases, than those of the smaller ones.

To explain some results, we must remember that the height of infantry remains the same in all formations in the same attitude (*i.e.*, whether lying down, kneeling or standing), and that, therefore, the size of the target can only be increased by spreading it out laterally.

This fact strongly points to the use of restricted groups on the battlefield, when serious action is not intended, with ample spaces between them when possible. *The more accurate the arm, the better the results obtained at small objects, but this difference is not so sensible on larger objects as grouped formations, against which a less accurate weapon is as good as a more accurate one.*

The combination of the errors of the rifle for different ranges with the mean trajectories allows us to get a very fair comparison of the dangerous zones of the arm.

Trace the mean trajectory until it meets the ground. (See Fig. 6, p. 59.) The theoretical dangerous zone extends from the point where it is a man's height from the ground to the first graze, not counting ricochets. But this is not all. Trace the enveloping cones of the vertical errors and prolong them until they also meet the ground. Then, not counting ricochets, the real dangerous zone is from A to G, where A is the point where the under side of the cone first comes within a man's height of the ground.

From Fig. 6, we see that there are really three distinct zones, viz., from A to C, called the *rear dangerous zone*; C to E, *the*

central dangerous zone; and E to G, *the front dangerous zone or beaten zone.* If the errors are greater than those supposed, or if the trajectory was more curved, there would be no central zone. This can be seen from Plate I.

All the space between C and E is the true dangerous zone of the rifle, as nearly 100 per cent. of the shots will strike between these points. This true dangerous zone depends both on the flatness of the trajectory and the accuracy of the arm. *If the trajectory is high, whatever the accuracy, it will be small. If the trajectory is very low, but the accuracy is slight, we shall at all events get a central zone of moderate length.* Hence we see that *flatness of trajectory is of more relative importance than accuracy.* The ideal of perfection of fire is an almost straight trajectory with such an accuracy that at the greatest distance of firing the diameter of the circle of the double probable error does not exceed the height of the enemy. We are still far from this.

The exact length of the dangerous zones shewn on Plate I. are for the given distances, which latter can rarely be exactly ascertained in the field, even with range-finding instruments, and even if the range is exactly known, the variations caused by the powder, the barometric pressure and other known and unknown causes, render it impossible to obtain this zone accurately, under all conditions, and hence they are only approximative.

The dangerous zones for cavalry are greatly in excess of those for infantry, from their greater height and the greater chance of hitting them.

From the comparatively great depth of the dangerous zones we see that deep formations like columns, must suffer more than thin formations like lines, and hence these latter formations must always be used under effective fire.

The figures in Plate I. show *the inutility of individual long range fire*, from the small extent of the ground covered. With the 300 yards elevation, we have a dangerous zone six times greater than that of the 1,000 yards elevation, but when we also come to consider the far smaller area of the shot group at the shorter range, we are many times more likely to hit a man at 300 yards than at 1,000 yards.

At long ranges we must also consider the fact that ths effect produced does not correspond with the number of shots fired, and therefore, an enormous consumption of ammunition is required to obtain a satisfactory result. We must remember hat all our remarks are at present confined to the fire of

individual men, each firing at a different mark; the collective fire of masses will be considered later on. Long range fire is all very well where the supply of ammunition is unlimited, when it would only cease from the fatigue of the firer, or the choking of his weapon.

In a siege, when the position of the enemy's batteries are known and their position is in the limits of the range of the weapon, long range fire can be well used, for the soldier behind cover can rest his rifle and can fire over 200 rounds in a day without much fatigue. In this case he is not then obliged to confine himself to the 100 or 120 rounds which are usually only available for him in the field.

There is an absolute necessity in the field to take count of the consumption of cartridges, from the great difficulty of supplying them under fire. If the soldier begins to fire at 1,400 yards, he will have time to consume the greatest part of his ammunition before producing any serious effect. Disregarding a few slight losses, the enemy will advance in an extended formation up to 600 yards, at which distance he will begin to experience serious losses. If the enemy has reserved his fire, and if his soldiers have fired but little, they will begin at this distance a fire which will be almost decisive, from the moral and material effect it will have; a moral effect, because the soldier, who sees that his fire does not stop the enemy, gets nervous and loses confidence in his arm; and a material effect, because the enemy has a greater number of cartridges to fire, and consequently, by keeping up a careful fire at 600 yards and under, may use up their opponents' cartridges, and then advance to 300 yards, at which distance the effect of fire is terrible, and the side which has used up all its cartridges is lost, and perhaps destroyed without being able to reply. A disordered rapid flight cannot save it, as bullets travel quicker than legs, and in the time a man takes to run 400 or 500 yards (say 2 minutes) he can receive 20 shots from his adversary, who aims at his ease, as he runs no danger. It will not be a fight, but a massacre.

The French regulations of 1875, laid down. "The attackers advance in deployed groups until the enemy's infantry fire becomes dangerous at about 800 yards; then the groups must be deployed, and the march continued in this formation. At this period a slow fire is to be opened by the scouts only." The utility of this has been queried by many French writers, who rightly consider individual fire to be useless at such ranges. Scouts in advance are useful to get information of

the ground, but they should not waste their ammunition by firing at such long ranges. The French regulations go on to say, "on reaching 600 yards, at which distance fire can be used with advantage, it will open along the whole line." Then follow the details for the continuation of the attack, until the enemy is approached to within 300 yards. "At this distance a rapid fire is delivered to cover the position occupied by the enemy with a hail of balls, to destroy the moral force of the defence, and to raise that of the attack. After some moments of this rapid fire, a quick advance is to be made, &c." "The enemy may abandon his position, either because he feels his inferiority, or because he *has used up his ammunition*, or because his flanks are turned, &c." These passages are all the more remarkable because the French used a general long range, individual fire at from 800 to 1,500 yards with some success under certain favorable circumstances in 1870-71, especially in the battle of Gravelotte at St. Privat.

Want of ammunition has often caused an attack to cease, as well as to cause a position to be abandoned.

In the war 1870-71, no useful effect was gained by the long range individual fire of the French infantry against the German extended formations. It certainly caused serious losses to closed masses, but it had comparatively little effect on the Prussian infantry in dispersed order, so that this infantry could always advance up to 400 yards, the then maximum range of their rifle, from which they opened fire without much disadvantage. The same remark applies to the long range individual fire of the Turks, and the attacks made by the Russian infantry in 1877-78.

Fire at long ranges, is a negation of the offensive, and should be avoided for this reason alone as a general practice.

Hitherto, we have supposed the distance to be exactly known, and, if we now consider the great errors made in judging distances, we realize how greatly the efficacy of fire at long ranges may be diminished, especially as the distances increase it is harder to judge, which increases the errors, while the length of the dangerous zone decreases.

From what has been said in the foregoing pages we can now see why it is that the knowledge of the accuracy of an arm (*i.e.*, the probable chance of hitting), combined with the mean trajectory, is absolutely necessary, if we wish to know exactly the value of its fire, on an object of given dimensions at known and unknown ranges.

Officers who have to determine the direction and intensity

of the fire, such as those commanding the firing line, must have this knowledge. A knowledge of the dangerous zone, as determined by the mean trajectory only, is of no practical utility to an officer, but he ought to know as well both the size of the group of bullets which envelop the purely theoretical trajectory, and the flatness of the trajectory. It is only by the combination of these data, accuracy and flatness of trajectory (both of which vary according to the range), that the probable efficacy of a fire can be calculated, if the range is known and the sight properly adjusted to it, with no disturbing wind, and if the point of mean impact coincided with the point aimed at—conditions which rarely exist, except for the shortest ranges, showing the uncertainty, and therefore probable waste, of long range individual fire. From a knowledge of the heights of the trajectory and of the errors of the Martini-Henry rifle, given on p. 53, simple graphical representations have been drawn (see Plate I.), which shows in a striking way the diminution of the efficacy of fire according as the range increases.

The French musketry regulations of 1877, limited the fire of the mass of infantry on the practice range to 600 mètres (660 yards), and those of 1875 insisted on the inutility of fire at long ranges, and on the necessity for infantry reserving its fire for close ranges. *A sight graduated up to high ranges (say beyond* 1,000 *yards) is a permanent source of danger for imperfectly trained troops commanded by inexperienced officers. They should be taught that this sight (with which it is also very difficult to fire) is only meant for some very rare and particular cases, such as in sieges, where ranges can be accurately measured and the effects watched, and that in the field, after* 800 *yards (putting down the outside limit), the individual fire of skirmishers has no efficacy, whilst under* 600 *yards it is dangerous, and its effect is decisive as soon as we are within* 400 *yards.* This was the experience of the Franco-German and Russo-Turkish Wars.

Taking all things into consideration, from the flatness of the trajectory; the errors of an average shot; the appearance, for aiming at, of the size of the object at the range; from being the limiting range at which a dangerous zone, grazed by the whole cone, exists throughout its length when aim is taken at the feet; from the probability of the error in judging the distance being commensurate with the dangerous zone; and from the dispersion of the bullets being not too great; the range of 400 yards appears to be the maximum range at which an average shot should be allowed to

fire individually, when the range has to be guessed, and then only at objects the size of a single upright man. Single horsemen may be fired at up to 450 yards under similar conditions. Good shots might be allowed to fire up to 600 yards, and very good shots to 800 yards, *but only if the range is known, and the probable effect of any wind not very great.* At short ranges, up to 400 yards, causes of error such as weather, density of air, lighting up of sights, drift, wind, and other deviating causes, have only a slight effect.

Some Observations on Range, Flatness of Trajectory, and Accuracy.

At 400 yards, every shot can be put into a six feet square target by a good shot, but taking a number of men we find that only from 30 to 60 p.c. of the shots hit, and we also find different results obtained by the same men in different years, and under different instructors. *The difference in the results obtained, will always depend more on the instruction acquired, than on the theoretical value of the arm. Whatever may be the theoretical accuracy of this arm, if the instruction of the soldier is bad, the results must of necessity be only moderate.*

The following is of great importance for military rifles. An examination of all results of firing, shows that *the most accurate arm has only a real superiority when the object fired at is of small dimensions.* In such a case, a very small amount, more or less, in the errors of the rifle is not to be disdained. But on targets representing even a simple group of men, or the head of a column of fours, the difference of results obtained, is only slightly felt with an ordinary firer. *It is only very good shots alone, who can appreciate the value of, and make good use of a more accurate arm.* Thus, if at 300 yards range the mean absolute error of one rifle is 7·9 inches, and of a second one 12·5 inches, a very good shot will obtain the following percentages on the circular targets against them.

Diameter of Circular Target.	P.C. of the First Rifle.	P.C. with Second Rifle.
$4\frac{1}{2}$ feet.	100	99·5
3 ,,	100	79·0
$1\frac{1}{2}$,,	76	45·0

But an ordinary firer who can get only 40 p.c. of the above results on the $4\frac{1}{2}$ foot target, will not get anything like this

percentage on the $1\frac{1}{2}$ foot target, whichever rifle he fired with. He would scarcely get to 10 or 12 p.c. of the above results on the smaller target, because the deviations caused by his want of skill are much greater than the difference between the two mean absolute errors, which is only about 4·6 inches.

All the experiments and trials made by us and other nations at *known ranges*, give much the same percentages, and show that practically all the present rifles for war purposes have the same *accuracy* in the hands of a large number of men, and that *the value of the results depends much more on the instruction of the men than on the arm itself*.

But when we come to consider the *flatness* of the trajectory, this is not the case. *At unknown distances* it will have an enormous influence on the results. Two rifles fired by the same man, when the range is only approximatively known, will give very different results according as the curvature of their trajectories permits of a greater or less error of elevation of the sights. The lower the trajectory, the greater may be the error allowed in appreciating the distance to get the same result. Judging distance is always a difficult matter to do, even with fair accuracy, and the difficulty increases rapidly with the range, while the shot groups also increase, and the practical dangerous zone rapidly decreases at the same time, and so intensifies the error. Everything points to the inutility of long range individual fire, and the necessity of keeping such fire for the shorter ranges of 400 yards and under.

We now see why accuracy of fire, though it plays an important *rôle*, is placed after range and flatness of trajectory in order of importance (see p. 11) in the qualities of a military rifle. However, these three factors are so connected, that they cannot be separated without giving partial, and, therefore, erroneous impressions. We cannot employ in our calculations a purely linear trajectory, but we must envelop it in a cone of trajectories, governed by the usual errors made in shooting, and it is by so doing that we can be certain of the value of the results, and be able to compare the relative value of any arms.

Range and flatness of trajectory are the first considerations, as they remain the same for all firers, and any progress in them, is a progress for the whole mass.

Accuracy is, therefore, in a certain measure, subordinate to flatness of trajectory and range. When it is sufficient, it is

not indispensable to increase it, for this increase can only be utilized by the best shots, and not by the mass, but still, when increased accuracy can be conveniently obtained, it is advisable to do so, for it helps to increase the dangerous zones of a good shot.

Thus, a military rifle ought to have a fairly long range, with the flattest trajectory and greatest accuracy possible.

The question of the accuracy required for a military rifle is well stated in the following extracts from lectures given in the Royal United Service Institution, by Colonel V. D. Majendie, R.A., in 1867 and 1869 respectively:—

"Extreme accuracy is, of course, a good thing to have in a military rifle, just as well as to have a watch which will beat time like a chronometer; but for ordinary circumstances of warfare a rifle of average precision will answer all our purposes, just as a chronometer movement is not absolutely essential in every day life. If we can get the extreme accuracy in either case, without sacrificing other qualities or without great outlay, well and good; but men exposed to a searching fire, hurried, wearied, confused, surrounded by smoke and strange noises, wounds and terror, will fail generally in giving good effect to the precision of which even a moderately accurate arm is capable." Again, "I have always held a strong opinion that it is unwise to sacrifice to exceeding accuracy of shooting, other qualifications. If you cannot obtain such accuracy without serious loss, without incurring a danger of fouling, without unduly lengthening or strengthening your cartridge, without unduly increasing your strain, then assuredly the extreme accuracy should be thrown overboard. But it will hardly be contended that if without any such loss you can secure an exceedingly accurate rifle you should not secure it. For ordinary purposes of warfare this great niceness of shooting is, I admit, not necessary."

CHAPTER VII.

RAPIDITY OF FIRE.—USEFUL EFFECT.

Rapidity of fire is the possibility of firing the greatest number of shots in a given time. Many think that the value of breech-loading arms depends on the rapidity of their fire. Though we must not exaggerate the importance of rapidity of fire, yet we must take it into serious consideration. *The object is attained by reducing to a minimum, the time required to load the rifle.* We must be very careful not to look upon a breech-loading rifle as an arm for rapid fire, but as a rapid loading arm, which allows a man to be always ready with it when a favourable moment comes, because *very* rapid firing is generally inaccurate and worthless, and causes a deplorable consumption of ammunition, from its usually being unaimed, and, perhaps, not even fired from the shoulder, especially if the firer is excited. The only case when unaimed rapid fire is permissible, is when a thick line of the enemy is very near (*i.e.*, within 200 yards).

The rapidity of fire of military rifles is nothing else than a result of facility of loading, and of being able to keep up the fire.

All breech-loading arms are either simple breech-loading or magazine arms. The former have to be loaded every time, after firing, with a cartridge taken from the pouch, the latter have a magazine, either in the butt or under the barrel, or one that can be attached, containing from 6 to 10 cartridges, which are put into position for firing by an automatic mechanical movement. *The rapidity of a continuous fire with these magazine arms is only greater than that of the ordinary rifle as long as any cartridges remain in the magazine.* After that, even if the soldier has time to refill it, the rapidity of fire in a given time becomes the same as that in a simple breech-loading rifle, at all events, with the magazine rifles that are at present before the public.

A simple breech-loading rifle can be fired about 6 to 10 times in a minute from the shoulders and with aiming. It can be fired quicker from the hip, without aiming, and by jerking the trigger. The Martini-Henry rifle can be thus fired twenty-five times in a minute.

The best magazine rifle, with its magazine full, can be fired 15 to 18 times in one minute without taking it from the shoulder, after which it can only be fired at the rate of an ordinary breech-loader.

Thus, practically a large number of rounds such as 100, *if fired as rapidly as possible*, can be fired by either kind of rifle in about the same time, 7 or 8 minutes.* But with such fire we must consider the excessive fatigue that it causes, the right shoulder becomes bruised and very fatigued by the recoil, and the muscles of the arms and shoulders, especially those of the left arm, become unsteadied by a sort of nervous trembling; the rapidity of fire quickly diminishes, notwithstanding any muscular efforts which tend still more to weaken the firer, and so takes from his fire any kind of accuracy, that the best shot would miss a battalion column at 100 yards under such conditions.

Colonel Campe says:—"The rapid fire (at the final stage of an attack) ought not to last more than five minutes; 40 or 50 well aimed shots fired by each man ought to suffice, especially when the artillery has prepared the attack and shaken the enemy. If the fire lasts longer, the men begin to fire badly, and finally the fire slackens. The moral effect that one wishes to produce on the enemy diminishes or vanishes, and the enemy has then time to bring up reinforcements to the threatened point. On the other hand, the increasing ardour that the offensive movement, aided by the firing, has given to the men, dies out by degrees. A rapid fire always creates confusion, an evil which is not slow in passing into the minds of the men, who soon see and hear nothing, and finish by escaping from the control of their leaders. It is necessary, therefore, to move forward at the end of five minutes."

Colonel von Scherff is of the same opinion. "The physiological influence of a rapid fire on the nervous system of the combatants is such that, at the end of a very short time, which cannot reasonably last more than five minutes, the troops on the offensive will either dash forward or retire."

The French regulations fix the duration of the rapid fire at the last stage of the attack at three or four minutes.

The Belgians, in 1881, carried out some experiments on the duration and rapidity of a rapid fire. The following is

* When the fire is not carried out as rapidly as possible, far more rounds can be fired from a magazine rifle than from a simple breech-loader. See p. 502.

the account given of them. "The necessity of a rapid fire, executed at the distance where a rifle has its full efficacy, is generally admitted now-a-days. But independently of the physiological influence, of which Von Scherff speaks, it appears necessary to ask whether, in this rapid fire, the rifle would not become so heated, at a given moment, that the men firing would find themselves compelled, by this fact alone, to suspend their fire.* This evidently would depend on the degree of rapidity attained by each man in the fire, which latter would be so much the more quickly interrupted or suspended by the heating of the barrel, as the skill of the man in loading and firing quickly was greater.

"On account of this consideration, 100 men have been made to fire individually (with the Albini rifle) as quickly, and for as long a time, as possible. The men were ordered to aim, and the number of cartridges fired by each man, and the time taken to do so were recorded, and are given in the following table, the numbers in which give an idea of the great differences which exist between different men.

TABLE VIII.

Time employed. m.	Time employed. s.	Number of Cartridges fired individually by each Man.
2	10	17-25-19-20
2	40	14
3	0	26-30-30
4	0	25-30-30-22-28-30-30-30-39-30-30-30-30
4	30	30-35-40-30-30
5	0	28-38-48-30-30-32-31-30-23-31-40-40-41-40-40-36-31-35
6	0	33-31-40
6	30	64-50
7	0	27-39-50-50-50-50
7	10	50
8	0	70-70-70-70-48-50-50-55-55

"These differences show that many men continued firing, in spite of the very sensible heating of the barrel, while others stopped prematurely.

"The result of this experiment shows that the average per man was 35 shots in five minutes, that is to say that in the

* This heating of the barrel is a very important question. In the new Enfield-Martini rifle, the lower part of the barrel is covered with a wooden casing, to preserve the men's hands from the hot barrel.

maximum time which a rapid fire should, according to the authorities given above, each man fired on an average 35 shots, or seven per minute.

"Hence, at the moment of opening the rapid fire, each man should have at least 40 rounds at his disposition. At the same time we must not lose sight of the fact that when the rapid fire ceases, the advance by successive rushes may have to be re-taken, which would require a further supply of ammunition."

The Belgians, again, made some further experiments in 1883, in rapid firing at a range of 250 mètres, during periods of three and four minutes. They wished to determine practically certain data, as follows:—

1.—The heating of the barrel.
2.—The average number of cartridges that a soldier can fire in one minute with the Belgian rifle, and consequently the number of cartridges a soldier should carry.
3.—The influence which a prolongation of rapid firing can have on the efficacy of the fire.

It was found that at the end of three minutes, the barrel, though hot, could be held, but not so at the end of four minutes.

The men, while aiming, and while only seeking rapidity of fire in rapidity of loading and in raising the rifle to the shoulder, fired nine shots a minute, or thirty-six in four minutes. Now, if an attacking force has advanced from 700 to 250 mètres by rushes of fifty mètres, and has fired three rounds at each halt, it will have expended twenty-seven rounds per man before reaching the 250 mètres range, which, added to the ammunition expended in a possible rapid fire of four minutes duration, makes a total of sixty-three rounds per man (or nearly all he carries at present) expended before the final assault and subsequent pursuit takes place, shewing that a considerable battalion supply must be carried, and that an increase must be made, as well in the amount carried by the men themselves, as the possibility of long range fire has also to be considered.

In comparing the results obtained after a rapid fire of four minutes with those obtained by a similar fire of three minutes, it was found that the relative efficacy of fire diminishes with the greater duration of the fire. This is due to the heating of the barrel, which alters the trajectories and makes the manipulation of the rifle more difficult,—to the fouling of

the barrel, to the accumulation of smoke which made it harder and harder to aim, to the fatigue of the men, and to the excitement which a prolonged and rapid fire produces on the nervous system. From this, it can be concluded that four minutes is the extreme limit during which a rapid fire can be kept up. But, in these experiments, the men were fresh and had not been previously moving and firing as they would have to do in action. Hence the inconvenient heating of the barrel and the extreme fatigue caused by rapid firing would probably be reached in about two instead of four minutes, in reality (especially if the bayonets are fixed), which is the practical limit already given.

Experience shows that the mass of men cannot support a really rapid fire for more than 2 minutes, while maintaining a reasonable accuracy, that is about 20 rounds with a simple breech-loading rifle, and 26 to 30 with the best magazine rifle.

Some similar experiments carried out in France showed that after men had been fatigued by being marched for four hours over bad roads, not only was the rapidity of the fire decreased, but also the percentage of hits. Consequently, the above results may be looked upon as maximum ones, especially at the end of a hotly contested fight.

Thus, *in a continuous rapid fire,* magazine arms do not lead to a waste of ammunition any more than ordinary breech-loaders, while in certain cases in war they may be most valuable, especially for the defensive, when magazine rifles would have an advantage over ordinary breech-loaders from being able at a given moment to deliver a much more rapid fire, and to pour in a greater mass of projectiles, which would probably have a decisive effect. At close ranges, rifles of all kinds have about an equal value as regards accuracy and flatness of trajectory and then it is that rapidity of fire must be taken into account in considering the final result.

The comparison of rifles, by their range, flatness of trajectory, and accuracy only, is not sufficient to give an exact idea of what these weapons can do in war. The value of a fire depends not only on its possible destructive power, but also on the promptitude of this action, called its *useful effect.*

The rapidity of a fire is expressed by the number of rounds expended by one man in one minute, and it is found by multiplying the total number of shots fired by 60 and dividing by the time of firing in seconds multiplied by the number of men firing.

Thus, if 82 men fire 526 shots in 1 min. 12 sec. (72 seconds), the rapidity of fire is $\frac{526 \times 60}{72 \times 82}$ or 5·34 shots per minute per man.

The rapidity of a fire rarely requires to come up to 10 rounds a minute; 1 to 4 rounds a minute is ample as a rule, depending on the distance of the enemy.

The useful effect of a fire is measured by the probability of hitting by the rapidity of the fire, and it can be defined as the number of hits made by one man in a minute on a given object. It is found by multiplying the number of hits made by 60, and dividing by the time of firing in seconds multiplied by the number of men firing.

Thus, if 124 hits have been made in 72 seconds by 82 men, the useful effect is $\frac{124 \times 60}{72 \times 82}$ or 1·26 hits per minute per man.

The rapidity of fire and useful effect are often calculated per 100 men.

From the above, we can see how it is that a quicker and less accurate fire may give a greater useful effect than a slower and more accurate one. As a general rule, as the rapidity of fire increases, the *percentage* of hits decreases, but the useful effect or total number of hits may be much increased.

The exclusive object of rapidity being thus dangerous to accuracy, it results that efficacy of fire only increases with the rapidity up to a certain limit, after which it diminishes, and hence we should not exclusively try to increase the rapidity of a fire, nor to hurry on its execution.

We see that in calculating the useful effect we only consider the results obtained in a given time, without reference to the amount of ammunition expended.

For accuracy, on the contrary, only the results of the fire are considered, without reference to the time employed in obtaining them.

In the field, against troops in column, or against any object which has depth as well as width and height, the useful effect depends also on the flatness of the trajectory, or rather the dangerous zone.

All progress in weapons tending to increase the rapidity and ease of loading, also increases both the rapidity and useful effect of fire.

CHAPTER VIII.

DETERMINATION OF DISTANCES.

THE importance of this subject is best shewn by the following quotation from a lecture given on Range-finding by Captain Watkin, R.A., in 1881, at the R.U.S. Institution.

"The necessity of knowing the distance of the object to be fired at is not one that is forcibly brought to notice under the present system of training. All, or nearly all, firing takes place at measured ranges. The soldier on coming to the practice ground is told at what elevation to put his sight, and is satisfied when he makes a good score. How bitter must be his disappointment when he comes to actual warfare and finds that his fire, which was apparently so deadly at home, is harmless at the very time when it is a matter of life or death that it should be effective. Look, on the one hand, at the annual returns of the shooting of the Army, and on the other, at the actual results obtained in the last campaign in South Africa. What is the reason of this? Chiefly, I believe, because our soldiers are not taught (as they might be) to fire under conditions more nearly assimilating to those of actual service. For example, if dummies were put up as targets on broken ground, the men would soon find out how powerless they were to make effective practice, unless the distance were truly estimated, and would take a much keener interest in educating their eyes, even, perhaps, tolerating the use of an instrument that would help them out of their difficulty. Our artillery practice is, I consider, even more at fault, for though there may be some skill in holding a rifle straight when the range is known and the target stationary, there is absolutely none required to lay a gun under similar circumstances. The artillery also labour under the disadvantage of a very limited supply of ammunition; but I believe both these drawbacks to efficiency could be easily overcome without any increased expenditure. Anyone who has seriously tried to estimate distances, must have found how difficult it is to do so with even approximate accuracy on familiar ground and at short ranges. In a strange country, and at longer ranges, the unaided eye is so unreliable as to give results quite useless for any practical purpose. In the days of

smooth-bores and Brown Besses, the correct estimation of the range was perhaps not a necessity, the difference between any two rounds fired under similar conditions being considerable, but now that we have such guns as the 6-inch and 8-inch, which are capable of sending fifty out of a hundred shots into a vertical target, 4×5 feet, at a distance of a mile, surely it is worth while taking a little trouble to ascertain the distance, without which every round would be lost.

"The following advantages would, I believe, be gained, if an efficient system of range-finding were introduced into the Army:

"1st. A demoralizing effect on the enemy by a fire efficient from its commencement.

"2nd. A steadying effect on our own men.

"3rd. A check on reckless expenditure of ammunition.

"4th. A consequent saving in transport.

"But these advantages are not to be obtained by the course hitherto pursued; the distribution of a few range-finders to the Army without any organized staff, or system of training, is of no use whatever; it is courting failure, and throwing discredit on the whole subject.

"The opinion of Officers of high standing, and of great practical experience, is that the power of our artillery might be enormously increased by the habitual use of range-finders in the hands of properly trained men. Unless, then, some such system be organized, we shall soon be left hopelessly behind other nations, who are devoting care and attention to the subject."

The following remark was made with reference to artillery fire, but refers equally well to infantry fire:—"The unsatisfactory practice at unknown ranges whilst manœuvring rapidly, shows that a large quantity of ammunition may be wasted without the fact being observable from the battery, and points to the necessity of some means being provided for ascertaining in the field, and, within reasonable limits, the distance of the object to be fired at." Without knowing the range within sufficiently approximate limits, a large quantity of valuable ammunition, and all the more valuable from the difficulty of transporting it to the field of battle, is absolutely wasted.

In order to be able to fire accurately with any rifle whatever, the soldier must know the distance between him and the object to be hit.

For instructional purposes in shooting, these distances are fixed and laid down by direct measurement; but before an

enemy the distances are unknown, and it is necessary to appreciate them in the most prompt and exact manner possible in order to regulate the fire.

Skill in appreciating distance is therefore the indispensable complement of skill in shooting.

These two processes are taught at first separately, but they should afterwards be applied together in "field firing."

There are several ways of ascertaining the distance of an object with a more or less degree of accuracy:—

1. By direct measurement.
2. By the use of optical instruments called "range-finders."
3. By the use of the plane table or prismatic compass.
4. By judging distances by sound.
5. By comparing the height of a distant standing or mounted man with a known height.
6. By the use of a large scale map.
7. By the practice of artillery near at hand.
8. By watching bullets strike the ground.
9. By judging distances by the eye.

1. Direct Measurement of Distances.

The direct measurement of distances, if carried out with a measuring tape or chain, is the most accurate method of all.*

They can also be paced, for which purpose a man must know the average length of each of his paces, and to do this he should be made to pace up and down a measured distance of 100 yards and find out how many of his paces go to that distance, from which the length of his pace may be got by a simple proportion sum. Men in testing their paces over a measured distance are very apt to increase the length of their paces towards the end, especially when several trials are made, in order to make the numbers agree. They should be carefully warned against doing this, and they should practice pacing until they can pace 100 yards within 2 or 3 paces each time on all grounds.

If the man can step 111 paces in 100 yards, then he has only to deduct $\frac{1}{10}$th of the number of paces stepped to find

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* If the ground, over which the measurement is made, slopes much, a correction must be made, in proportion of the cosine of the slope, to get the true horizontal distance, if this is required.

the corresponding distance in yards. This gives a very natural length of pace, namely 32·4 inches, which is stepped by most men.

Yards may be paced, if a man can do so, but to do this easily and without constraint, he must walk at a rate of 4 miles an hour.

The average error of pacing is 3 per cent., or $\frac{1}{33}$rd of the distance.

But this method of measurement is quite inapplicable in the presence of the enemy, though the distances can be measured before he arrives.

2. Measurement of Distances by Optical Instruments.

Distances can be measured by optical instruments called *range-finders.* They are all based on solving a triangle with a known base of from about 15 to 120 yards, the greater base being required for the greater range. As a rule, the generality of them can only find a range in about four minutes to within about 4 per cent., or $\frac{1}{25}$th, of the truth with average men, though with some instruments and under favourable circumstances it can be found to within 2 per cent., or $\frac{1}{50}$th, of the truth in $2\frac{1}{2}$ minutes by skilled men.

At the longer ranges—*i.e.*, over 600 yards—it may be possible for infantry to use such instruments, if the men can do so without attracting the enemy's attention, but certainly at closer ranges, during the din and smoke caused by the engagement of large bodies of troops, and under fire, the use of such instruments is no longer possible by infantry, and hence we see the necessity for having a rifle whose trajectory (when using a full sight*) is under the height of a man up to 600 yards.

In England, we have a Sub-committee of the Ordnance

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* At the short distances, just before the time for the decisive attack, the enemy will make use of all the accidents of the ground to cover himself; his presence is only shewn by the smoke of the discharged rifles, the removal of the wounded, or the movements of the men who leave one shelter to reach another, or to gain ground to the front. These short and rapid appearances can only be made use of if the distances can be rapidly appreciated and the men are quick at aiming. For this latter purpose, a full sight is better than a fine sight. And hence it would seem better to graduate the backsight to suit a full sight. Other reasons for this have already been given.

Committee for the purpose of considering the question of range-finders and their relative merits. But this Sub-committee have not issued any set of conditions, for the guidance of inventors as to what they consider a range-finder must fulfil before it can be accepted. This should most certainly be done,* together with the offer of a considerable reward, for inventors often do not really understand what is required, and as the question is a most important one with modern rapid-firing, long-range rifles, and the service Watkin range-finder is not suited for use with a rapidly advancing infantry attack, some settlement should be arrived at at an early date to prevent the waste of ammunition which a very wrong estimation of the range causes. The following headings may be taken as a guide as to the requirements which an infantry range-finder should fulfil, so as to be applicable for use by infantry in action† :—

1. Cost moderate, so that *every* officer, and even non-commissioned officer, might have one.
2. The total amount of equipment required for use with it to find a range to be small, and to be easily replaced in the field if lost or broken.
3. It should be compact, of few pieces, of light weight, small size, and requiring only to be held in the hand, without the use of any tripod so as to be very portable, and capable of fairly rough usage without sustaining damage.
4. It should be easily and rapidly packed and unpacked, and got ready for observing.
5. It should require no delicate manipulation, education of the eye, or mathematical knowledge. The ranges should be given, for preference automatically or by a simple multiplication or division sum. It should not require the use of verniers or microscopes.
6. It should be easy and convenient to use.
7. It should not require being placed with extreme accuracy over a given spot, which only causes delay.
8. Its maximum error should never be greater than 100 yards at 1,500 yards, so as not to require more than two elevations to be used in combination. (See Chap. IX.)

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* This has just been done for the first time, see service papers for 26th May, 1888. It is to be hoped that this excellent precedent will be extended to all other army *materiel* requiring improvement.

† See pages 381 and 382 for the general conditions which a range-finder should fulfil for this purpose.

9. It should be of strong and simple mechanism, not easily put out of, or constantly requiring, adjustment; but it should be capable of being tested to see if it is in adjustment, and, at the same time of being readjusted accurately when this is found necessary.
10. It should be capable of easy repair, if damaged.
11. It should only require, if possible, one man to take a range, but not more than two men, who would otherwise get in each other's way, and attract the enemy's fire.
12. It should be capable of taking a range in two minutes at the most.
13. It should, if possible, allow of ranges in different directions being obtained from the same base.*
14. It should be capable of being used by men kneeling or lying down.
15. It should be capable of being conveniently and rapidly used by advancing infantry, who make periodical short halts.
16. It should be capable of being used with a telescope or other magnifying apparatus.
17. It should be easy to teach to men.
18. It should not require a longer base than the length of a rifle, if possible, or of over 50 yards for the longest ranges ever required to be fired over by infantry, and, if possible, means should be provided for obtaining the length of the base without direct measurement. But this latter condition is not very important, as the observer has, as a rule, to pass from one end of the base to the other, and he can pace it while doing so. For this purpose accurate pacing is required, which should, therefore, be frequently checked over measured distances.

At ranges over 600 or 800 yards, time and circumstances allow of a 50 yards base being paced in comparative safety,

* The only range-finders amongst those that are now in general use, that *partially* fulfil this requirement are the Bate and Dredge-Steward instruments. All the others require an alteration in the direction of the base with any change in the direction of the range required. The Nolan instrument also fulfils this requirement, but there are other objections to this range-finder, which will be pointed out further on. The Mallock range-finder is the only one which perfectly fulfils this requirement. (See p. 110).

and consequently of the range being taken with a range-finder requiring a greater base than the length of a rifle. With such a range-finder, once the range is found, the subsequent ranges can be found by deducting the distances traversed by the advancing line, hostile or otherwise, as determined by pacing or estimation. Range-finders requiring only a 5 feet or smaller base, and capable of reading to within 50 yards up to 800 yards, should be carried by officers and non-commissioned officers for determining ranges under 800 yards; one of the other kinds, requiring a longer base, could be carried in each company by a non-commissioned officer trained in its use. The Mallock range-finder seems to promise great things as a short base range-finder.

It must, however, be remembered that, "In order to obtain the full benefit of any range-finder, thoroughly competent observers must be employed. To hope that any method of range-finding can be used by men who are unskilled, is a delusion."

It is a most important point to know the capabilities of range-finders for rapid use in an advancing infantry firing line in action at ranges over 600 yards. Under that distance the accuracy of a trained enemy's fire would not permit of much work of that sort, and the probable errors made in guessing the ranges under 600 yards would be, more or less, in keeping with the practical dangerous zones (if we include the effect of ricochets) of the rifle at present in use, and will be quite in keeping with any of the proposed rifles of the future.

We will now give a short account of the principal different optical range-finders that have been proposed. They may be grouped in three types:—

1*st type.*—Those requiring a fixed short base, as Clerk's Guthrie's, Adie's, Berdan's, and Mallock's.

2*nd type.*—Those partaking of the nature of a theodolite, as Nolan's.

3*rd type.*—Those partaking of the nature of a sextant, as the Sextant, Watkin's, Poste's, Drayson's, De Bylandt's, Weldon's, Robert's, Goulier's, Gautier's, Labbez's, Dredge-Steward's, and Bate's.

The optical range-finders of the first type find the distance by the amount of displacement of the object as seen from either end of the base. But this arrangement, which appears simple and correct in principle broke down until lately, in practice, owing to the great difficulty of superimposing the images with

exactness, from these images being so very unsteady on account of being reflected from single mirrors.

But Mr. Mallock has lately devised an instrument,* consisting of a tube only 2½ or 5 feet in total length, and which can be carried in parts; it has two mirrors set at 45° at one end and two mirrors set at 45° to one another when the index is reading zero, but which angle can be slightly altered by a micrometer screw. A telescope looks partly into one of the two last mirrors and partly past it. The instrument can be held vertically or horizontally by one man, and 10 readings can be taken by him within two minutes with only a maximum error of 100 yards at a range of 2,500 yards, and 50 yards at a range of 1,500 yards when the 5 feet base is used; with the 2½ feet base the maximum errors are 100 yards at 1,500 yards and 50 yards at 1,000 yards. The use of the four mirrors, instead of two, prevents, for reasons that cannot be gone into here, any errors due to a slight bending of the tube being felt. It requires no apparatus, it only requires one man so work it, it contains its own base, it gives the range directly from a scale, and it is easily adjusted and tested. It, in fact, is the one and only instrument which almost entirely fulfils all the conditions laid down on pp. 107, 108, and on pp. 381, 382, and it can be perfectly easily used by an advancing infantry line in action. The only disadvantage in the instrument is the loss of light that occurs in the reflected image from its being reflected four times. Its weight in its present experimental form is five pounds.

The *Berdan Range-finder* used by the Russians is carried on a cart, and consists of two very large telescopes fixed at a distance of 6 feet apart, one of them being capable of a slight angular displacement. To obtain the range, the cross wires of both telescopes are directed on to exactly the same portion of the object, and the angular movement of the movable telescope, as registered by a micrometer screw, gives the distance. This instrument does not fulfil the 16th condition given on p. 108.

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* This instrument is exactly similar in principle to one invented by Capt. Gautier (not the same instrument as that mentioned on page 114). It was shewn at the Paris Exhibition of 1867, and is explained in Vol. XVIII. of the R.E. Professional Papers of 1870. Capt. Gautier's range-finder would seem admirably adapted for artillery purposes, and claims to measure distances up to 6,000 yards accurately enough for practical purposes.

The *Nolan Range-finder* consists of two separate telescopes, mounted somewhat like theodolites, placed on two tripods or gun carriages some distance apart, by which the two base angles of the triangle can be measured, and the range found by means of a calculating disc, when the base is known. This was at one time the service range-finder, but it has since been superseded by less cumbersome and equally accurate ones.

The third type of optical range-finders, like the others, find the range by the solution of a triangle. With the Sextant, and with Watkin's, Poste's, and Drayson's instruments, the triangle solved is a right-angled triangle. The right angle is laid off at one end of the base by an optical square, carried separately or contained in the instrument, and the angle at the other end is measured by the instrument which, when the base is known, gives the range either automatically, or in multiples of the base, or from a table. One fault of the Sextant type of instrument (the Sextant, Watkin's, and Poste's) is that they are affected by parallax, an error due to the distance apart of the glasses, and this parallax varies inversely as the distance of the object directly looked at. In the Sextant only can this error be found and allowed for. Under favorable conditions, ranges can be found by means of the Sextant (even a pocket one) and suitable tables, with surprising accuracy.

The *Watkin Range-finder*, which is the present service one, is, in reality, only a sextant, in which the horizon glass is movable, and the index glass is fixed,* and hence, as the horizon glass moves, the position of the eye must be moved accordingly. To save the trouble of direct measurement, the same instrument is made to measure the true base by means of a subsidiary base 18 feet long, and after adjusting a sliding pivot to the true base on a graduated bar, the range is denoted automatically on a drum, the movement of which alters the position of the index glass slightly in order to measure the angle at the opposite end of the base to the right angle. This instrument is affected by parallax, and if used by an unpracticed observer very different results can be obtained for the same range, from the difficulty of holding it exactly in the true plane passing through the observer's eye, the object observed, and the head of the picket at the other

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* In the Sextant the horizon glass and the position of the eye opposite it are fixed, while the index glass, attached to the index arm, moves.

end of the base. The inventor states that with this instrument ranges can be found in two minutes to within 1 per cent. of the truth, but such accuracy and rapidity is not generally obtainable, as extreme accuracy is required in laying off the right angle, in holding the instrument exactly over the ends of the base, and keeping it in the plane given by three fixed points. It is too expensive, and its accessories are too large and numerous for it to form any part of the equipment of an officer or non-commissioned officer, while it is not an easy instrument to learn. But the adjustments are easy, it is one of the most accurate instruments yet invented, its size and weight (independently of the pickets that have to be used with it) are convenient, and two men are the most required to work it. It is, however, well adapted for artillery purposes, when its equipment can be easily carried.

Poste's Range-finder, or *Macrometer* as it is called, is an instrument in which a slide rule is fitted to a sextant, and it gives the range in multiples of the base, which may thus be of any suitable length. An optical square is used in conjunction with this instrument. Two men are required to lay out the right angle, and the base has to be measured. The instrument is affected, like a sextant, by parallax, and being a foot in length and three inches in width, it is rather too bulky to form part of the personal equipment of an officer, while it is rather expensive.

Drayson's, *De Bylandt's*, and *Weldon's Range-finders* are all on the same principle of working with fixed angles (given by prisms or by two fixed mirrors), the range being a fixed multiple of the base employed. Col. Drayson, many years ago, utilized the pocket sextant in this manner, by clamping the index glass at various angles representing different multiples of the base.* If the angle at one end of the base is a right angle, then, if the range is 10 times the base, the angle at the other end of the base is 84° 17′; if the range is 20 times the base, it is 87° 8′; and if the range is 40 times the base, it is 88° 34′. Col. Drayson finding that persons unused to sextants had some difficulty in setting the index arm to any given angle, had four instruments made with fixed glasses, one to show 90°, and the other three to show the angles given above. After setting off the right-angle, the observer moves along the base line until the object and the other end of the base

* In this method, the index error of the sextant must be found first, and allowed for.

are superimposed on one another in the instrument; the base is then measured and multiplied by the multiplier required for the instrument used to obtain the range. In 1872, De Bylandt brought out a very similar instrument to show angles of 90° and 87° 8′, requiring a base one-twentieth of the range; but a second instrument with mirrors arranged to read angles of 5° 42′ 30″ was also employed to do away with the trouble of direct measurement, by measuring the true base by means of a subsidiary base one-tenth its length.

The *Weldon Range-finder* is very similar to the above; at first the same angle (88° 34′) was used at both ends of the base, thus laying off an isosceles triangle, the base of which is one-twentieth of the range. Double reflecting prisms have been used in this case in preference to fixed mirrors. Latterly, however, the Weldon instrument consists of three prisms, two of these reflect the angles of a right-angled triangle of which the perpendicular or range is 50 times the base (viz. 90° and 88° 51′), and this kind reflects an angle of 74° 53′, and is used for measuring the true base by means of a subsidiary one one-fourth its length. The angle of 88°. 51′ is first laid off by means of a distant mark, and then the position of the right angle is determined by again reflecting the object, whose range is required to be found, on to the mark. Fifty times the base gives the range. By this method one interior and one exterior angle of the triangle are laid off and not two interior angles, as the Watkin instrument does.

The former of these two systems has been found to give better results than the latter, and it is the system employed with the Goulier, Gautier, Labbez, Dredge-Steward, and Bate instruments.

At first the Weldon instrument laid off 2 interior angles, and, consequently such good results as have been latterly obtained were not got with it.

The great advantage of the above instruments is their extremely small size and portability. But it is very hard to grind the prisms truly* or to adjust the mirrors accurately, and there are no means of seeing if they are out of order or not; small personal errors of observation, which must occur if the observer is tired or excited, or the objects observed are indefinite, tell very greatly on the range found by their aid. They have, of course, no magnifying power, and would be hard to use with a bad background, such as trees or a cloudy

* This difficulty is reported to have been overcome by Col. Weldon.

sky. There are other most serious objections to these fixed instruments, which require a base of fixed proportions, namely, that for long ranges a very long base is required, and as the base has to be a certain fixed proportion of the range, it is not improbable that on arriving at the end of the base so fixed in length and direction, it will be found that some intervening object prevents any view of the object whose range is desired. These instruments give about as accurate results as the Watkin range-finder, which may be taken as a standard in this respect, as it attains the accuracy requisite for the effective use of a properly executed fire in the field. The adjustment of the fixed mirrors is not easy, but little or no equipment is required with them, the time of taking a range is under two minutes, and two men are the most required to work them.

The Robert's Range-finder consists of a telescope (with a prism giving angles of 90° attached to it) on a tripod, a graduated rod about 6 ft. long and a mechanical calculator. It is unnecessary to go into the working of this instrument, for the mere fact of its having to be used in a tripod, renders it unfitted for use with infantry under fire.

The Goulier Range-finder measures the angle subtended at the object, whose range is required, by a *fixed* base, whose length has to be ascertained by direct measurement. The disadvantages attendant on *fixed* bases have been given under the heading of the Weldon range-finder.

The Gautier Range-finder measures the angle subtended at the object whose range is required, with any base, and it gives on a scale the multiple of the base used to find the range. This instrument is used in France, but has not been brought to England yet.

The Labbez Range-finder measures the same angle, a natural or placed object (situated at any distance over 50 yards) being used as a mark to work by, but it is graduated for a base of 30 yards, though bases whose lengths are multiples or submultiples of 30 yards may also be used, the range found being divided by the proportion used. It is not quite such an accurate instrument as the Watkin range-finder; with a base of $\frac{1}{100}$th of the range, the maximum error is said to be about $\frac{1}{30}$th of the range, and with a base of $\frac{1}{50}$th of the range, about $\frac{1}{70}$th of the range. The range can be found in one minute with this instrument, and its use is very easily taught to men. The instrument leaves the manufacturer's hands adjusted, and it cannot easily get out of

order; but should it do so, however, it has the disadvantage of not being capable of being put right again without being returned for repair. As however, the accuracy of the instrument does not depend on an exact right-angle being laid off at one end of the base, any slight deviation in the mirror would not affect the practical working of it. It moreover requires no extra apparatus.

Both of these last two instruments are very small and compact * and are now the instruments used in the French Army. The bases have to be directly measured or paced, which is not a very great disadvantage, as the observer has to move from one end of it to the other. As these instruments measure the angle at the apex of the triangle, no very appreciable error would occur if the base was not exactly at right angles to one side of the triangle, provided the construction of the instrument allowed of this being done, but as the Labbez instrument only allows a latitude of about 5° in the choice of the direction of the base, this advantage cannot be claimed for it.

The Dredge-Steward Range-finder has the appearance of a small box-sextant. It works on the same principle as the Gautier and Labbez instruments, but it has the additional advantage that it can also be used on the principle of the Watkin instrument (of measuring the two interior angles of the triangle) in case of necessity. It gives the range in multiples of a certain base, or of multiples of this base, as with the Labbez range-finder. It is rather more accurate than the Gautier or Labbez range-finder but not so accurate as the Watkin.

The Bate Range-finder is the least known. The principle on which this range-finder works is, that it actually plots on a brass plate, by means of two graduated limbs and a movable gauge, the triangle formed by the two ends of the base and the object whose range is required. This theoretically allows of any latitude in the choice of the direction for the base, but practically the instrument only allows of the base lying anywhere between 30° on either side of the perpendicular to the

* The Gautier instrument is about 6 inches long and $1\frac{1}{2}$ inches in diameter, while the Labbez range-finder, without telescope attachment, is only $1\frac{1}{2}$ inches long, 1 inch in diameter and weighs $3\frac{1}{4}$ ounces, while with telescope attachment, and reel with 30 yards of wire, it folds up into a cylinder $1\frac{1}{2}$ inches long, $1\frac{1}{2}$ inches in diameter, and weighs $6\frac{1}{2}$ ounces complete. The wire is more to test the pacing from time to time than for direct measurement of the base, which takes time, and cannot well be carried out under fire.

range. It is permanently attached to a pair of field glasses. The instrument gives the range in multiples of the base, which has, therefore, to be measured. Ranges have been found with it as accurately as with the Watkin instrument, while it does not require any apparatus and takes the range more quickly. Two men are the most required to work it, it is easily learnt, it does not require any adjustments to be made, and it can be fitted to any pair of field glasses. The method of using a gauge to determine the multiples of the base from the graduated limbs is one of the most accurate mechanical methods known for measuring small dimensions.

One of the greatest advantages that a range-finder can have, is to allow of a considerable latitude in the choice of the direction of the base, and the Bate Range-finder is the only one at present which fulfils this condition in some degree. The great disadvantage of having a fixed direction for the base is that in a defensive position on the crest of a ridge or plateau, the fixed direction of the base may be such that one end of the base is behind the crest line, and the distant object, whose range is required, cannot be seen from it.

Taking everything into consideration, weight, size, portability, time and apparatus required for taking a range, the probable errors to be expected in doing so, and ease of teaching, probably the Dredge-Steward and Bate range-finders are those most suited of the sextant type of the instruments for infantry officers and non-commissioned officers. In comparing expenses it must be remembered that a pair of field glasses, which every officer must carry, is included in the Bate instrument, which is no more expensive than a pair of field glasses and a Dredge-Steward range-finder. Messrs. Elliott Bros., 101, St. Martin's Lane, Strand, are the manufacturers of the Bate range-finder, and Messrs. Steward, 406, Strand, London, of the Dredge-Steward range-finder.

But the best instrument of all for infantry purposes is the $2\frac{1}{2}$ feet Mallock instrument. Officers could easily carry this in place of field glasses, as it is used with a telescope. A 5 ft. instrument could be carried per company or per battalion for the better determination of long ranges.

3. Measurement of Distances with the Plane Table and Prismatic Compass.

For troops in a defensive or stationary position, with ample time, and at some little distance from the enemy, the plane

table is not only the very simplest, but at the same time one of the most accurate instruments for finding ranges. It finds the ranges by plotting triangles to scale. Any base can be used to obtain good triangles, and the ranges of many objects in different directions can be found from the same base, while the saving of time in taking such a number of ranges is considerable. It only requires one man to work it. Since the value of the plane table as a surveying instrument has been recognised, it will always be found with an English army in the field, among either the Staff or the Engineer stores, and indeed it would be a great advantage for one to be carried in the regimental stores of every battalion.

The prismatic compass can be used in the same way, though it is not nearly so accurate as the plane table. But neither of these instruments can be used in an advancing infantry line, and hence they can only be looked on as auxiliary methods which can be used under suitable conditions.

The plane table and prismatic compass give the horizontal distance of the objective from the observer; all other methods of finding the range give the actual length of the line joining these two points; the differences, however, in the ranges obtained on account of this, will not, in most cases, be of sufficient importance to be taken into consideration.

4. Measurement of Distances by Sound.

Sound travels at the rate of 1,113 feet or 371 yards in a second, when the temperature of the air is 50° F., and this rate increases or decreases at about 1·0966 feet for each degree Fahr., for temperatures respectively above or below the one given above; the velocity also increases somewhat with the loudness of the sound, but these variations cannot cause any serious error in the ranges estimated by sound.

Wind, the humidity of the air, and barometric pressure strongly influence the *intensity* of the sound, but very slightly its *velocity*, and hence, in ordinary circumstances, they do not cause any sensible errors in the appreciation of distances by sound.

When the smoke or flash of a rifle or gun is seen, there exists a certain time before the noise of the explosion is heard. If this time can be estimated in seconds we can calculate the distance the sound has come.

This method is particularly advantageous when opposed to a well sheltered enemy who fires without being seen. Besides

which it is susceptible of considerable accuracy (to within 50 yards of a range), which allows of its use in different circumstances when the direct measure of the distances is impossible.

The time between the sight and sound of the explosion can be estimated by the aid of a mental counting at a given rate, which can be learnt thus. Take a lead ball and hang it by a thread to a nail so as to oscillate freely. The length of this pendulum between the point of suspension and the centre of the ball should be exactly 39¼ inches. The time of each oscillation of this pendulum, that is the time taken by the pendulum to go from one end of the swing to the other, is one second. The rate of counting that should be learnt is to count 11 in the interval of 3 oscillations,* because sound travels 1,100 yards nearly in that interval, and then as a man counts the units of the natural numbers, 1, 2, 3, 4, 5, 6, etc., beginning with 1 directly he sees the smoke or flash, each unit corresponds to a distance of 100 yards.† Thus the number 6 counted between the smoke and the sound would correspond to 600 yards. As one is very apt to lose the proper cadence, continual practice is essential. A watch with a second hand can also be used for this by officers. The counting should begin directly the smoke is seen, or else large errors will arise, but it requires practice to do this.

"This counting can easily be acquired by most soldiers, no artificial instrument being needed; this faculty is one thing in favour of this method of calculating distances, another is, that while by other methods the greater the distance the greater the proportionate error, in this it is the reverse, the greater the distance the less the proportionate error; this method is not one claiming to supersede others, but it is a useful and simple adjunct."

In the quiet of the night this method of judging distance by sound after seeing the flash is very good.

However, this method has some disadvantages. The appreciation of distances by sound presents great difficulties in a continuous fusilade, or when the firer is so sheltered

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* If the pendulum is 2.92 inches in length between the point of suspension and centre of the ball, each swing will represent 100 yards.

† Theoretically the count should begin at 0 directly the enemy is seen to fire, but practically the brain cannot take up the count so quickly and the sound has travelled some distance before the count is begun, and consequently it has been found that better results are obtained by beginning the count at 1 instead of 0.

that the smoke is only visible some instants only after the shot has been fired. If there is much noise going on around, as when firing, it drowns the sound of the enemy's shot, and if the enemy is firing much any one particular shot cannot be selected to judge from, as all the sounds run into one another. There is another serious drawback to this method, which is, having to wait until the enemy commences firing.

Judging distances from the fire of a single rifle is difficult beyond 1,300 yards, and is impossible beyond 1,600 yards.*

From the sound of the simultaneous fire of a body of 50 men, distances can be judged up to 3,000 yards, and by the fire of artillery up to 6,500 yards.

Instruments for measuring ranges by sound are much used by the French and other Continental nations. They are simple, cheap, and, *under favourable conditions*, give results not to be surpassed by other kinds of range-finders. Two different kinds will now be referred to.

The Boulengé Range-finder or *telemeter* consists of a closed glass tube about 6 inches long filled with benzine, and contains a silver traveller or indicator, formed of two discs connected with a central wire. The diameter of the discs is rather less than that of the tube,† and the traveller descends slowly‡ and uniformly when the tube is held vertically, from the resistance of the liquid in it. A scale showing every 25 yards is engraved on the tube, the intermediate readings being estimated by eye. A wood or copper covering preserves the glass tube from breakage. One end of the instrument can carry a small compass, and the other be utilized as a shrill whistle. The instrument, with the indicator at zero, is held horizontally in the hand, the back of which is kept uppermost, and when the smoke or flash of an enemy's gun is seen, it is rapidly placed vertically and replaced horizontal when the report is heard. When each observer knows his only personal error (which is about $\frac{1}{7}$th of a second on an average) and applies it, the maximum error is 25 yards for all ranges, while very often no error is made at all.

At Hythe it was found that under 400 yards the time was too short between seeing the flash or smoke and hearing the

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* At Hythe this distance was found to be 1,000 yards.

† The dimensions have been calculated so as to equalize, by its expansion, the error caused by the expansion of the liquid and the increased velocity of sound, due to an increase of atmospheric temperature.

‡ It has a velocity 25,000 times less than that of sound.

report to use the instrument with success, while over 1,000 yards the smoke and report of a single rifle were not properly seen or heard. Artillery can be seen and heard at a longer distance. Under 400 yards, however, the flatness of the trajectory is such that an accurate estimate of the range is not essential.

The Watch Range-finder exactly resembles a common watch in appearance. The two hands are placed at XII. or zero. A small spring catch is placed on one of the wheels, so that, after the watch has been wound up, the slightest pressure on the spring catch releases the wheel and the hands fly round, the long hand 12 times faster than the small hand. On removing the pressure from the catch, both hands are stopped instantly, and the number of revolutions made by each of the hands is registered on the face of the watch since the instant the pressure was applied, and a comparison of this number with a table gives the distance of the origin of the sound. Ranges can be read with this instrument to within 10 yards, especially if the officer knows his personal error.

The great fault of all range-finders depending on the velocity of sound is that we must wait the enemy's pleasure to fire, before we can ascertain the range in his presence.

With regard to judging distances by sound the English musketry regulations say:—

Judging distance by sound can only be looked upon as auxiliary to judging by sight.

It might be useful, under favourable circumstances, at long range, and in front of a well-posted enemy, who fires occasional shots from cover without showing himself; and it is the only method by which distance can be judged at night. It is certainly quicker than the range finder, and can be used when the latter cannot, and by its means long distances can be judged more accurately than short distances. With a body of men properly instructed, the mean of errors should not exceed 50 yards.

It is, however, useless to try to judge distance by sound when the enemy's fire is well sustained, or when his men are sheltered in such a way that the smoke can only be seen some instants after the shot has been fired. It is difficult to judge distance from the report of a single rifle beyond 1,200 yards, and impossible to do so beyond 1,500 yards.

Section volleys will enable the distance to be judged up to 3,200 yards, and the fire of artillery up to 6,500 yards or nearly 3¾ miles.

5. Measurement of Distances by Comparison of Known Heights.

The principle of this method is to ascertain the distances by the variable angle an object of known height subtends at different distances. The objects chosen are a standing man, or a mounted horseman, of average height, that is, these objects are made the distant base of a triangle whose apex is at the observer, and the distance is found by similar triangles.

To effect this, telescopes have been used, having in the focus of the object glass two horizontal wires, the distance between which can be varied. Other scales seen against the wires gives the distances at which a standing or mounted man would fill the space between the wires. These instruments have not proved satisfactory, and besides, standing men or horsemen vary in height and may not be fully seen, while the instruments require strong steady tripods to enable the wires to be laid on the object. Also a distance is often required where there is no man to be seen to judge from.

A very simple though rough method of appreciating distances has been lately proposed in France. Its advantages are its simplicity and lightness, and that it gives distances more accurately than when these are guessed by the eye alone. The instrument, if it can be called such, is only the figures of a standing and kneeling man ($\frac{1}{50}$th of the real size) drawn on and cut out of the edge of a piece of cardboard, sufficient paper being left at the base to enable it to be held by the forefinger and thumb. An assistant holds this up steadily and the observer moves backwards until the cardboard figure agrees in size with the man observed in the distance. The distance between the observer and the man holding the cardboard is measured, and multiplied by 50, to obtain the range. Taking 5 feet 6 inches as the average height of an upright man, the theoretical error caused by observing men 5 feet 3 inches and 5 feet 10 inches would be less than $\frac{1}{16}$th of the distance sought. If the distance between the observer and the assistant is measured by pacing, we may have a possible error of $\frac{1}{33}$rd of the range. These two errors acting together might cause an error of $\frac{1}{11}$th of the range. Added to these, is the difficulty of precisely judging when the figure exactly coincides with the object observed. In France, out of 30 measurements, only one had an error as great as $\frac{1}{8}$th the range, while the mean error was only $\frac{1}{22}$nd of the range. It is not necessary to see

the whole object; it is sufficient if only the upper part of the man's body can be seen, but if the cardboard figure is lit up more than the object, it should be shaded. This process can be used in clear weather up to 1,100 yards and over, but it is best to use field glasses with such long ranges. The disadvantage of this method is that it requires a bit of ground sloping parallel to the line of sight to the enemy, and hence could not be used on the crest of a position or on ground that does not slope as required, and further, in the presence of the enemy it requires the enemy to show himself.

6. Measurement of Distances by Maps.

Ranges can be measured from maps drawn to a large scale. The accuracy of this method depends on the scale of the map, but on a one inch map ranges can be measured to within 25 yards, and on a six inch map to within 5 yards, by the aid of ordinary dividing compasses. Thus this method is one of the most accurate ways of ascertaining a range, but, on the other hand, such maps are not always available, and the exact position of the enemy on the map cannot always be known with certainty.

7. Measurement of Distances by the Fire of Artillery.

The ranges of certain objects fired at by artillery can be obtained from the artillery officers when they are near enough at hand; and then knowing these ranges, others can be judged by comparison with them. Artillery can easily ascertain ranges up to 1,500 yards by watching the burst of their shells, and seeing if they fall short or over, and so regulate their sights, but at longer ranges it is very hard to say what the amount of such an error may be.

As infantry pass by artillery in action, they should always enquire the range, and then deduct the amount they move forward.

8. Measurement of Distance by the Fire of Infantry.

In a similar way, under favourable circumstances, the "strike" of a large number of bullets (the Germans say from

80 men, the Austrians, 8 to 14 men) fired simultaneously at the same object can be watched. But the method is only suitable for distances over 600 yards from the enemy,* and the fall of bullets cannot be seen, even on favourable ground and with strong glasses, over 1,300 yards.

If the ground is at all stony or hard, or covered with grass or standing crops, or in wet weather, the strike cannot be observed at comparatively close ranges, and even with a good telescope and on favourable ground, the strike cannot be seen beyond 1,300 yards, nor consequently the elevation corrected.

In the Umbeyla Campaign (1863) on the north-west frontier of India, a certain number of explosive bullets were taken for ascertaining ranges, which proved very successful; but explosive bullets are no longer allowed in war by the Declaration of St. Petersburg, dated 11th December, 1868, to which Great Britain attached her consent.

9. Measurement of Distances by Eye.

If we have no other means of finding the range of an object, we must judge or rather guess the distance of it.

Judging distances by sight depends on the degree of visibility of the object, on the distinctness with which it can be seen, on its apparent height when its dimensions are known, and on the comparison of its distance with a known distance that a man has either marked down before him, or engraven on his memory.

The distinctness with which any object at any particular distance is visible varies considerably with different men, and no inflexible rule, for estimating distances, can, therefore, be laid down. Further, judging distances is a very difficult operation to do with anything like accuracy, as so many physical circumstances, such as the position of the sun, the time of day, the nature of the lighting, the state of the atmosphere, the nature and colour of the background, whether the intervening ground rises or falls, &c., affect the appearance of the object and its apparent distance, so much so that one-

* See Chapter XIV. for reason why "volley" firing cannot be used under this range in action.

eighth of the estimated distance may be considered as the *minimum* possible error at the longer ranges, even when judged by at least four practical and skilful observers, and the mean of their observations taken.

The American regulations state that the mean errors of estimating distances are—

At 300 yards	..	$\frac{1}{10}$th	the estimated range.
At 600 yards	..	$\frac{1}{8}$th	
At 1,200 yards	..	$\frac{1}{6}$th	

But the rules for firing in continental armies are based on an average error of $\frac{1}{8}$th the estimated range at all distances, and consequently this value of the error of judging distances will be the one used throughout the following pages.

Objects seem nearer the better they are lighted ; the larger they are, the brighter their colour ; the darker the background against which they stand, the purer the air ; the more uniform the tint of the ground between them and the observer. They look further off when looking towards the sun (*i.e.*, when the sun is in our eyes), and *vice versâ*. The clear, cold air of winter, or after a thunderstorm, makes objects look clearer and nearer, while snow, rain, fog, powder smoke, or the vapour caused by the heat of the sun makes them look further off. Bad weather makes objects look confused and further off. A smooth expanse, as fields covered with snow, cornfields, or water, has the effect of rendering the distances apparently shorter. Ground falling from the observer has the same effect, and the contrary when it rises. Undulating ground tends to make objects look further off, while flat ground has the contrary effect. In the clear air of mountains objects look much nearer than they really are.

Men must be exercised first at known, before they can judge unknown distances. Each man should try and remember what parts of the figure, arms, accoutrements, dress, &c., of men he can clearly see at different distances. Too minute observations should be avoided and the upper parts of the bodies should be examined in preference to the lower parts, as these latter are often masked; the colour of the uniform need not be noted, as it is different for different armies and even for different branches of the same service.

The Russian Colonel Kaulbars, in his well-known report on the German Army, states that general rules used in Germany for estimating ranges are as follows :—

"At 50 mètres a man can see the mouth and eyes of an enemy clearly.
,, 100 ,, ,, ,, the eyes as points.
,, 200 ,, ,, ,, the buttons and different parts of the uniform.
,, 300 ,, ,, ,, the face.
,, 400 ,, ,, ,, the movements of the arms and legs.
,, 500 ,, ,, ,, colour of the cloth."*

But each man must form rules for himself, because the same ones cannot hold good for all men, as the strength and clearness of vision of different men vary considerably, and objects will naturally vary in appearance according to the eyesight of the observer.

The height of the foresight, when the rifle is in the firing position, covers half the height of an infantry soldier at 200 yards, and the whole height at 400 yards.

Beyond 650 yards it is difficult to estimate the range from the appearance of single men alone; squads of 3 or 4 men at least, should then be examined in different attitudes.

Judging distances should be practised by men and officers over all kinds of ground, in all directions, in all weathers, and at all times of the year, to show them the practical difficulties of appreciating distances by sight, and how the appearances of men and objects are modified by their situation, according as they are lit up or in shadow, or on hilly or flat ground, or in cut up or open country.

As a rule, short ranges are over estimated and long ranges under estimated; the range which each man can usually estimate correctly varies with the man, but it is about 500 yards for most men who have had sufficient practice. It is an advantage, however, to slightly under-estimate the longer ranges, because experiments have shewn that in collective firing a better result is gained by using elevations rather under that for the exact range than by using the proper elevation.

From what has been said we can see that as so many considerations affect it, the eye is the very worst means of judging distances, no two men will give the same answer, for practically it is entirely guess-work, and the greater the inaccuracy of the method of judgment the more it

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* This is in reference to the dark blue and dark green uniforms used abroad. English red can be distinguished at much longer distances.

is to be deprecated, as it causes greater waste of precious ammunition.

The inaccuracy of judging distances by eye is further increased in action, by a want of coolness in those judging, who are themselves being fired at and are consequently excited and nervous.

The latest German Musketry Regulations, in treating of the appreciation of distances, gives preference to the method of guessing ranges by eye, principally by means of the remembrance of known distances, well engraved by practice on the memory of the soldier, and also by comparisons made of the different appearances which the human body, and the dress, arms, and accoutrements, present at different distances. But the regulations adds as a warning, that comparisons of this kind on the person of an enemy are always difficult to make in war, in the usual conditions of battle. The Germans teach their men by constant practice in varied ground to judge distances up to the limit of individual fire only, *i.e.*, up to 400 mètres exactly, and up to 800 mètres approximately, and their officers and non-commissioned officers up to 800 mètres exactly, and up to 1,200 mètres approximately, the extreme limit that they consider that infantry fire should be used up to (see Chapter XII.). But in every German company, the 6 or 8 men who show the best aptitude for judging distances are, while placed under the orders of a non-commissioned officer, distributed along the extended firing line, and in action, after every forward movement of their own side or of the enemy, they call out to the non-commissioned officer what they judge the range to be, and he informs the officers what is the average of the estimates made. This is an admirable system and one worthy of imitation.

The Germans train their men to estimate distances more by the remembrance of known distances "well engraved" on the mind than by the different appearances of an enemy's body at different ranges, because "the conditions of combat rarely permit of such observations being made on the person of the adversary as can be utilised for the estimation of distances."

Consequently the men are thoroughly exercised in engraving on their memory the distances of 50, 100, and 200 mètres by repeated exercises in varied ground; these distances when impressed on the memory, then serve as "units of measure," for estimating distances while remembering that

the same length on the surface of the ground appears shorter as it is further from the observer.

To train the men, the above three distances, are picketed out on the ground in different directions across the front and away from the men. The men are made to observe when standing, kneeling, and lying down, the different appearances of these lengths at different distances and in different directions. The men are then tested at unknown distances, which distances they have to measure with a cord of known length or by pacing. The causes of any errors of evaluation are explained (see page 124.)* When the men are found efficient at estimating distances up to 200 mètres they are then trained to estimate distances up to 400 mètres, and after that up to 800 mètres.

For estimating distances over 200 mètres and up to 400 mètres, one of two methods can be used, viz.:—

1. The observer estimates how many large units of measure, (*i.e.*, of 100 or 200 mètres) there are in the distance, and the remainder he divides by eye into fractions of 50 mètres.

2. The observer seeks some point which he thinks divides the distance in half. He then divides by eye the nearest half again in two, until he thinks he can accurately estimate the portion of the range nearest him, which he multiplies by twice the number of divisions he has made.

Should anything interfere with finding suitable points for sub-dividing the distances (as when a deep dip occurs in the intervening ground, or when the distance is across water) then the observer can choose an object in another direction which appears to be at the same distance, and judge its distance.

The German regulations prefer this second method, on account of the difficulty of estimating the fore-shortening of the unit of measure, as the distance increases.

Distances up to 800 mètres are estimated in the same way by the men; and officers and non-commissioned officers are trained in the same way, to estimate distances up to 1,200 mètres.

The regulations also recommend that the men should have impressed on them, the lengths of certain distances which they have to go over daily, or which are continually before their eyes, such as the dimensions of the parade ground, the length of a portion of a road over which they habitually pass, etc.

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* The German regulations say, that in a combat, distances are generally *undervalued* especially in the lying down or crouching position.

Résumé.

From the foregoing we see that direct measurement of distances is only possible when the enemy is not present; range-finders, such as are at present in use, except the Mallock instrument which may not be at hand when required, are only available over 600 yards and then only under favourable conditions; judging by eye is available at all times, but is a most inaccurate method; judging by sound, though very accurate, is only applicable in certain cases but not for general use under all circumstances; judging by comparison of heights is only better than by eye; artillery may be some distance off and allowances have to be made for the distance of the observer from the guns, and for any difference in distance between the objectives; the strike of bullets can rarely be seen; and maps may not be available.

However, judging by eye, in spite of its inaccuracy, is the only method suitable for general use at all times, and therefore it should be constantly practised. The mass of the privates and corporals should be able to judge distances up to 600 yards, and some specially trained men, sergeants and officers, up to the extreme graduation of the rifle or to 1,400 yards, to within one-tenth of the range, so that, under the more unfavourable circumstances of war, they can rely on finding them to within an eighth of the range.* Field glasses should also be made use of if necessary. The mass of the men should not be trained over the above distances, for if so, they will then think they may fire at such ranges.

Judging distances, difficult in peace time, is still more so in war, where the opponents are continually moving.

It should be carefully impressed on every man how useless the fire of an individual man is unless he is capable of estimating correctly the distance of the object aimed at. This difficulty not only increases with the range, but in a more rapid proportion.

When on the defensive, and if time permits before the arrival of the enemy, *the ground and slopes around the position should be studied with care, the distances of all important points should be measured with the greatest exactness*, and other positions marked, if necessary, by cairns of stone, bunches of straw, lopped trees, or other simple means, taking care to arrange them so that they will not benefit the enemy. The ranges when found should be handed to the immediate leaders of the men, so as to make their fire as terrible as possible at all stages of the fight.

* The above are the extreme distances laid down in the American regulations for training men and officers to estimate distances.

PART II.

CHAPTER IX.

COLLECTIVE FIRE.—COMBINED USE OF TWO OR MORE ELEVATIONS.—RICOCHETS.

The definition of *collective fire* has already been given on p. 79, and before going further we must warn the reader that we are now going to deal with conditions which are totally different from those governing an *individual* fire.

As we have seen in Part I, the efficacy of an individual fire depends (1) on the ballistic properties of the rifle, (2) on the skill of the man, (3) on his skill in appreciating distances, and (4) on atmospheric influences.

Further, in Part I., the inaccuracy and inefficacy of a frontal *individual* fire at ranges over 400 yards in the field was pointed out, from the extent of the errors in shooting; from the probable error in estimating the range, which increases with the range, not being in harmony with the dangerous zone, which decreases with the range; from the point of mean impact not being likely to coincide with the point aimed at; from the effects of deviating causes being appreciably felt; from the unknown variations required in the elevation on account of atmospheric changes; and from the effects of the fire not being seen, and hence from not being able to correct them.

In fact the wonder at first sight is, that, under such very adverse circumstances as have been enumerated in Chapter III. Part I., an individual man can hit a single enemy at all at ranges over 400 yards, but the explanation of the fact that men are killed and wounded beyond this range is that, (1) if the fire of a number of men be directed on the same object, then all the opposing influences already enumerated do not affect all the men equally, and some of the bullets are certain to hit the object aimed at, and also (2) that the enemy is in several lines of men close to, and close behind, one another, so that if the man aimed at is missed, one of those on either side or behind him may be hit.

The first of these conditions is the only one that it is in the power of either side to control or make use of, and it can only be attained *by a collective fire being directed on a named objective*, and not by each man firing as he pleases, which would only be the same as uncontrolled independent individual firing, because each man would then be firing at a different point or object in front of him.

In order not to create a wrong impression by the term "uncontrolled independent firing," it may be stated here that though individual men may be firing independently, yet they may all be firing (*a*) at one object, or (*b*) at different objects; the former is a collective fire, and points to its being controlled by a higher authority: the latter is the frontal and uncontrolled fire which we have hitherto considered.

Having stated the result that can be attained by collective firing, let us see how it can be best *conducted* to get the greatest effect from it, *i.e.*, to make the greatest number of bullets hit.

The first thing we see is that in order to get a collective fire the men must all fire at the same objective, and to do this they must be under control. *If the named objective has any breadth, the men firing at it need not all fire at exactly the same spot*, for a little consideration will shew that the effect will be exactly the same whether the fire be distributed along this front, or directed at any particular spot on it. But if the front of the named objective is not of the same density or size throughout, that is to say, if some parts of the enemy's line consist of men grouped together, and others of men extended, or, if in some parts men are standing up and in others lying down, then, of course, the firing would be directed on densest and most exposed portions.

When a body of men fire on the same object with nominally the same elevation, the men forming the *mass* who are firing, cannot all have rifles with the same peculiarities, or use identically the same elevations, have the same power of eyesight, use the same amount of foresight, have the same steadiness, &c., nor can they be similarly affected by the same moral influences, and hence their fire becomes spread over a considerable space, especially in the direction of the fire.

There results from this a number of trajectories which form, as a whole, a cone analogous to that formed by the fire of individual men, but which has much greater dimensions in all directions. The groups thus obtained, either on a vertical target or on the ground, may be called *collective groups*, and as

it is difficult from their size to collect them on a vertical target, especially when the range is rather great or the number of men firing is considerable, it is usual to note the groupings of the shots on the ground in order to study their distribution, and to ascertain the length and breadth of the *efficacious or beaten ground or zone**, as it is called, which includes the whole, or any given percentage, of the shots.

If the groupings of the shots for any given elevation or range be noted on the ground, or on a vertical plane, they will be found to form a kind of an ellipse, the greater axis of which is in the direction of the fire, and the hits in this ellipse will be found to be most densely grouped towards the centre of the surface struck, just as in the fire of a single arm.

When the ground is parallel to the line of sight, the depth of the ground struck by shots fired with the same elevation is found to decrease as the distance of the object increases.

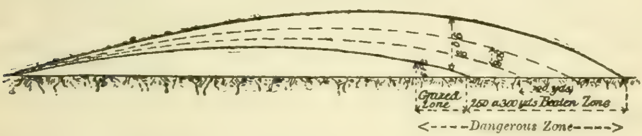

Fig. 8.

When a sufficiently large number of bullets are fired at different ranges of from 500 yards up to 1,400 yards, the beaten zone is equal to about 300 yards on an average at the shorter, and 200 yards at the longer range, if we only consider 90 per cent. of the hits, that is, deducting 10 per cent. for abnormal hits. Over 1,400 yards the depth of the beaten ground, for 90 per cent. of the hits begins to decrease more rapidly. But, if we only take the densest part of the group, including the best 50 per cent. of the shots, the beaten zone is about 150 yards at 500 yards, and 100 yards at 1,400 yards; or half these distances in front and half in rear of the point of mean impact, which latter should correspond with the range if the proper elevation nas been used.

Thus, if the body of men firing is divided into two equal parts, and the two halves simultaneously use sights differing by fifty yards, the depth of the beaten zone at 1,400 yards for

* The *dangerous zone* of a collective fire is the beaten zone, *plus* the theoretical dangerous zone of the lowest trajectory, given in Table I., pp. 8 and 9.

the best fifty per cent. of the shots is increased to 150 yards ; if two sights differing by 100 yards are used, this beaten zone is increased to 200 yards. If the body of men is divided up into three equal parts and use sights differing by 100 yards, this beaten zone is increased to 300 yards, and so on.

These numbers can be corroborated by means of the diagrams of musketry fire drawn up by the English Siege Operations Committee, from experiments made at Dungeness in 1879-1880. In all these experiments, executed by a body of men firing at the same object and with the same elevation, the *mass* of the bullets fell within the limits of 150 yards* under and over the range for which the elevation was suited, the intensity of fire being greatest at about the proper range for the elevation used, and decreasing gradually both ways, thereby enormously increasing the practical beaten zones of such a fire, practically making it over 300 yards for each range. This is very important indeed, because when the collective fire of a number of men is being dealt with, the practical dangerous zones of individual fire for a given range may be neglected as being too small to be considered.

Some experiments carried out in Belgium in 1881 and 1883 showed that:—

1. With trained and chosen men the best 50 p.c. of the hits covered 100 mètres at all ranges.

2. With average men the best 50 p.c. of the hits were spread over 150 mètres at ranges under 1,000 mètres; over 125 mètres at 1,000 mètres; over 100 mètres at ranges between 1,000 and 1,400 mètres; and over 125 mètres at ranges over 1,400 mètres. But this last result is due really to a change in the method of sighting.

Thus we see that trained and chosen men can obtain more restricted zones than can be got by ordinary shots. The French regulations say, "The depth of the beaten zone is

* The report of the Siege Operations Committee indirectly states this, as it says that with a body of men firing with 2 sights regulated for 1,250 and 1,350 yards, the distribution of hits at the range of 1,300 yards was fairly uniform over a depth of 400 to 500 yards, which gives the margin in the text above. And again, we find it stated, that when using two elevations in combination (see p. 139), differing by 200 yards, viz. : 600 and 800 yards, and the 900 and 1,100 yards elevations, the grouping of hits shewed a gap, indicating that a less interval than 200 yards between the elevations is desirable at the above-named ranges to cover the whole depth fired at. Too much reliance, however, cannot be placed on these experiments, as they only lasted for six months, and do not embody the experience of several years, as foreign statistics do.

sensibly constant, whatever the distance of the object may be; it is about 100 mètres if the best 50 p.c. of the hits or the densest part only of the grouping be considered." These numbers are not absolute, and can evidently increase or decrease with the skill of the men firing.

The different depths of the groupings obtained by good and bad firers show the influence of the skill of the men and of fire discipline on the efficacy of a collective fire. These influences are not the only ones which can make the depths of the beaten zones vary; there are others as well, such as fatigue, the emotions of the men, the inclination of the ground, atmospheric conditions, &c. There results from this that the fire of infantry cannot be compared altogether with that of artillery as regards its groupings. In fact, the fire of artillery is a fire from a fixed rest with a well-assured aim. It does not depend nearly so much on the nerves of a man, and the small differences which occur in the weights of the powder charges have much less influence on the ranges when the charges contain many thousands of grains instead of weighing from 70 to 85 grains only. Thus it is dangerous to rely on deductions found by calculation only as to the probable effects of infantry fire. The experimental method alone can give any results worthy of confidence.

The conclusions to be drawn from the above is that infantry should be as carefully instructed in collective as in individual firing during their annual course. It is also essential that the principles of fire discipline should be instilled into the men, and that they should be trained to fire perfect volleys, as these produce the best effect. It is also essential that even the smallest unit should have exact ideas on collective firing, and that men should know the distances at which they should make use of the different kinds of collective firing (see Chap. XV.).

The following explanation shews why the total length of ground beaten with the bullets of a collective fire decreases as the range increases. As the range increases, the angles of elevation increase more rapidly; or, in other words, an error of 1° too much elevation at 100 yards makes the bullet go 400 yards further, while the same error in elevation at 2,100 yards, makes the bullet only go 100 yards further. Thus, the longer the range, the less does a given small error in elevation affect the space over which the bullets fall; and therefore, the longer the range, the less is this space. When the rifles are fired from rests (see p. 241), this is found to be more the case than when

they are fired from the shoulder, which can be easily understood. At the shorter ranges, the mass of the bullets fall near the point of mean impact, but at the longer ranges they are more evenly distributed over the beaten zone; and thus it is that the central 50 per cent. of the bullets fall in about the same space of 100 yards, at all ranges, from 500 up to 1,400 yards.

We must be careful to separate the effects of bullets falling into a space on a horizontal plane and hitting a vertical target. Table II., on p. 21, shews that a constant slight error in elevation causes a largely increasing error in vertical height as the range increases: while, as shewn above, it causes a decreasing error in a horizontal direction, under the same conditions. This is the reason why it gets harder to hit a vertical target as the range increases, while the horizontal extent of ground into which the best 50 per cent. of the bullets fall, remains practically the same.

The above numbers are average ones and are by no means absolute, but may increase or diminish according to the skill of the men, and if rests are used; but the dispersion in depth, whatever it may be, still remains independent of the distance, if a sufficient number of rounds are fired, though it varies with the inclination of the ground on which the bullets fall, as will be shown later on.*

The surface of the horizontal group, which contains 50 per cent. of the hits, is called the *nucleus* of the group; that which contains the next 40 per cent., the *envelope of this nucleus*; and the hits produced by ricochets and the remainder of the shots is called the *tailing*.

The centre of the nucleus is the point of mean impact of the horizontal group, but the best 50 per cent. of the hits are very uniformly distributed over the nucleus, consequently, to get the best result possible, some part of the nucleus should fall on the object to be hit, and hence, in dealing with a collective fire, a knowledge of the range to within half the depth of the nucleus (*i.e.*, within 50 yards) is all that is required.

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* "From this it follows that the collective fire of several men at a single target, at distances over 440 yards, is not the true gauge of their efficiency. It is necessary that they fire at a series of screens, which will register all the hits; then, from their density, an estimate of the value of their shooting can be obtained. The position of the densest part of the nucleus offers no clue, as it does not depend on the efforts of the men, but on factors beyond control." (Major C. Brooke).

The width of the ground beaten, when a single point is aimed at, also increases with the range. The French regulations say that when all the rifles are directed at the same point the width of the group of hits in yards between 500 and 1,500 yards for the best 50 per cent. of the hits, is about equal to the number of hundreds of yards in the range (*i.e.*, 5 yards at 500 yards, 10 yards at 1,000 yards, &c.); it is 30 yards at 2,000 yards, and 60 yards at 2,400 yards. The width of the groups for 90 per cent. of the hits is about double that for 50 per cent. of the hits.

Captain Neunhauser, commenting on the Belgian experiments of 1883, says:—"It is necessary to remark that one of the great causes which makes the collective fire of infantry less accurate at long ranges than at the shorter ones, lies in the greater amount of the lateral errors, the deviating causes having so much greater influence as the distances become greater. In fact, the beaten zone is not a line but a surface. If the rectangle which contains the grouping of the best half of the hits is only a few yards broad at the short ranges, it tends to approach a square at the longer ones, and consequently, to increase the beaten surface. The grouping of hits is therefore less dense in this latter case, and the fire less efficacious, thus placing theory and practice in agreement."

Because the conditions of individual and collective firing are so different, the dangerous zones of a collective fire for the various ranges cannot be worked out in the same way as the dangerous zones for individual fire, and, indeed, we cannot lay down definitely, as can be done for an individual fire, any limits of efficacy for a collective fire by means of comparative values of the probable errors and the size of the target, but what we do see is, that the actual value of each of the zones of a collective fire depends on the theoretical dangerous zone of each bullet as well as on the extent of ground struck. The less the angle of drop, the greater are the number of bullets included *in the height* of the object fired at, so that the theoretical dangerous zones of individual fire given in Table I., p. 9, may be taken as giving some indication of the comparative value of a collective fire at different ranges.

The longer the range, the more vertically the bullets drop, and therefore the less dangerous is the beaten zone, or the efficacy of the fire from a given number of men. As the space over which 50 per cent. of the bullets fall remains nearly constant, this efficacy for different ranges

can be relatively measured, by the horizontal distance passed over by a bullet, near the centre of the nucleus, at the end of its flight, divided by the vertical height through which the bullet falls in that distance. The numbers thus obtained are given in column 7 of the trajectory table given on p. 8, and from this table we see that a collective fire at 1,700 yards will have only half the efficacy of one at 1,200 yards and one quarter of one at 800 yards and one eighth of one at 500 yards. This is supposing that the lateral dispersion remains constant as well as the longitudinal dispersion, which we know is not the case. Taking the lateral dispersions given on p. 135 as correct, the lateral dispersion at 1,700 yards is three times, and at 1,200 yards is about twice that at 500 yards, so that the efficacy of a fire at 1,700 yards is only about one twenty-fourth, and of one at 1,200 yards is only about an eighth that of one at 500 yards. This statement is far from being absolute, but it is only given as an example to show how the efficacy of the concentrated fire of a given number of men rapidly decreases with the range.

Thus, at *known ranges*, to get a similar effect, by a collective fire at 1,200 yards as at 500 yards, we must employ a considerably greater number of men (or rather amount of ammunition) than the number required to get the same effect if the same object is only 500 yards off.*

But, besides the efficacy of the fire decreasing so rapidly with the range, it gets at the same time harder and harder, as the range increases, to estimate the distance to within 50 yards, both of which conditions tend to make the fire less and less efficacious as the range becomes longer, so that there is a limiting range, after which any fire, although concentrated and aimed, really becomes hap-hazard or as it may be called "chance fire" however carefully the man may aim. Neither this limiting range, nor the result of such a fire can well be definitely stated, but the experience of the war of 1877-78, has shewn that a "chance fire" against troops in any deep close-order formations proved very terrible, when kept up by a mass of men at even such long ranges as 2,000 yards.

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* In battle, for moral reasons, it is better to expend the required ammunition as rapidly as possible by increasing the number of men firing. Sudden losses intimidate the enemy more than if the losses were more gradual; to expend the necessary amount of ammunition by making a few men fire a long time, takes all the offensive spirit out of them.

If the range can only be found by any means to a certain percentage of the truth, then a body of men all using the same elevation should not fire at a longer range than that at which *twice* * the given percentage of error is greater than the beaten zone for the range. Beyond this limit, an efficacious fire cannot be ensured, and ammunition is likely to be wasted, that is, too many bullets will be expended for the amount of good gained, which bullets would have been better kept for a shorter and more effective range.

We must therefore inquire what is to be considered in our calculations as the extent of the beaten zone? Is it to be the extent of ground struck by 90 per cent. of the bullets (300 to 200 yards) or that struck by 50 per cent. of the bullets (100 yards)? The latter value being almost a constant one, and having the hits almost uniformly spread over it, has been accepted by all Continental nations, and as they have experience, while we have none, we cannot do better than accept their conclusions as to what should be considered as the beaten zone for all ranges over 400 yards up to 1,400 yards; under the 400 yards range a controlled fire is hardly ever possible, as it becomes perforce a frontal individual fire from the excited and uncontrollable state of the men.

This central beaten zone of 100 yards, formed by the nucleus of a collective fire, is a very fair factor to deal with, because when the effect of ricochets is considered, 50 per cent. of the shots is a very fair allowance to take of the total number of shots. To try and utilize the whole zone for 90 per cent. of the shots would be pushing theory almost too far.

If the range can be found with a range-finder to within 3 per cent. of the truth, then a body of men all using the same elevation should not fire beyond such a range than that at which 6 per cent. of it is greater than the accepted beaten zone of 100 yards. Such a range is 1,700 yards. But in practice, and especially with the excitement of being in action and under fire, it will be hard to find such a long range so accurately, and as we have seen that at long ranges it requires the collective fire of a far greater number of men to produce the same effect as a given number of men at 500 yards, the

* In dealing with trajectories under the height of a man, as we have done in Part I., for individual fire, we have only used the percentage of error as the object fired at was supposed to be at a less distance only than that suited to the elevation used. But this condition no longer exists, and we must now use twice the percentage of error, as this error may just as well be over as under the true range.

above limit must be considerably reduced in practice to about 1,300 yards (see Chap. XII.) as the maximum range allowable in practice, and then only under favourable conditions.

Thus, firing beyond a certain range, say 1,300 yards, in round numbers, should never be attempted unless there is at hand such an unlimited supply of ammunition, as the Turks had in 1877-78 (which however can rarely be the case), and we can afford to waste some, because beyond that range the fire really becomes chance fire, the effect of which, is to cover a large area of ground with dropping shots which luckily may, and perhaps may not, do any damage to the enemy. We must not trust to luck and chance in war more than necessary, and never when we can avoid it, as can be done in this case. In future when we talk of "long ranges" we shall mean, until we more definitely express them, ranges somewhere about, but not exceeding, 1,300 yards.

In every case in firing at long ranges, a most careful "fire discipline," and control of the firing, must be kept up to ensure concentration, on the object to be hit, as the independent fire of individual men at long ranges is simply chance fire in its worst form.

The longer the range the more necessary is the collective fire of masses, or of large groups, of men, so as to concentrate a large number of bullets on the front of the same objective *The strength of these groups, or rather the amount of ammunition required, to ensure the same effect at each range, rises in a more rapid ratio than the range.* But even then there must be a limiting range beyond which firing away ammunition will be unprofitable, and which would have been better kept for ranges more adapted to the power of the rifle. This range cannot be laid down, yet it is certainly over the range of 1,300 yards, *but even this range is not generally available*, from the usually undulatory or covered character of ground, which allows of contending bodies to approach each other unseen to shorter distances.

If we have no range-finder, and cannot get the range from the artillery, or from maps, or by watching the strike of the bullets, or by any other means, the only way of getting the range of an object, is to judge or rather guess its distance. Judging distances is, as we have seen, a very difficult operation, from so many physical circumstances affecting the eyesight; so much so, that a writer in the *Revue Militaire de l'Etranger* says that the Germans allow ¼th of the estimated distances as the probable error to be allowed for in such cases, even when

judged by a number of practised and skilful observers (never less than four) and the mean of their estimates taken. That is to say, that the total limits of error are within one-third of the estimated distance; this seems an enormous allowance, but from a consideration of the rules of fire laid down in Continental armies, we shall see that a total error of one-fourth the estimated range is allowed for, which supposes a possible error of one-eighth of the estimated distance in judging the range by eye.

This limit of one-fourth the range, would require that, when all the men use the same elevation, and when the ranges are estimated by eye alone, a controlled collective fire should not be opened at a greater range than four times the constant beaten zone of a concentrated fire (4×100) or 400 yards, but a collective fire at such ranges is not required, from the accuracy and efficacy of individual fire within that limit, and from the flatness of the trajectories of the military rifles at present in use in all European armies.

Now the only way to get certain results at ranges over 400 yards, when the range is estimated by eye, is to divide up the body of men firing at a given object into two, or three, or more equal parts, as the case may be, and to make each sub-division use a different elevation at the same time. By this means, with a given number of men, a greater depth of ground is swept, though with a less intense fire than if one elevation is used by the whole body. The number of elevations to be used depends chiefly on the range and the constant beaten zone of 100 yards at each range. The greater the range the greater is the probable total error of judging it, and therefore the more elevations should be used, and also if the same intensity of fire is required at each range the greater, in the same proportion, should be the body of men firing, or rather the quantity of ammunition expended, than the number required if the range is known.

The number of elevations to be used is also somewhat governed by the consideration of the depth of the object fired at, and as to whether it is stationary or moving.* If the object has no depth, and is stationary, the range can be found with fair accuracy, by watching the effect of the collective fire on the enemy, *i.e.*, whether, with a given elevation, it has any effect on decreasing his fire at the point aimed at, or by watching the

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* For this purpose it is just the same whether the men are stationary and the object is moving, or *vice versâ*.

strike of the bullets where the ground is favourable for such a course. In such a case, one elevation only, or two at the most, would be required. Against very deep formations, as a battalion column of fours, which allow a considerable latitude in judging the range, because it does not much matter if the head or rear of the formation is hit, fewer sights are required than against shallow formations. But if the object is moving, and so constantly altering the range, a greater number of sights are required than if it is stationary.

But let us take the extreme cases, and then we shall know what we have to reduce in more favourable circumstances. As the beaten zone of a collective fire for different ranges is constant and equal to 100 yards, we see that to obtain a *continuous* beaten zone with the combined use of different sights, these sights must not differ from one another by more than the elevation for 100 yards.

Thus, when two elevations differing by 100 yards are used we get a beaten zone of 200 yards, and so when the range is guessed by eye, and we may have a probable limit of error of one-fourth the estimated range, a body of men should not fire at over (4 × 200) or 800 yards.

Similarly when three elevations, differing by 100 yards, are used, we get a beaten zone of 300 yards, and under similar circumstances, as above, a collective fire should not be opened in this case at over (4 × 300) or 1,200 yards. From what has been said before, we need not consider ranges over this.

At any distance, *if the range is known, only one sight should be used*, and two or three sights will only be employed according to the accuracy with which the range is known. The number of sights to be used is found thus,—Multiply the estimated range by twice the fraction of the range representing the probable error of estimation. This gives the distance over which the bullets must be spread. If the result is 100 or less, then one sight for the estimated range is sufficient. If the result is 150, then use two sights, one for 25 yards under, and the other for 25 yards over the estimated range. If the result is 200, then use two sights, one for 50 yards under, and the other for 50 yards over the estimated range. If the result is 250, use three sights, one for the estimated range, one for 75 yards under, and one for 75 yards over it; and if the result is 300, use three sights, one for the estimated range, one for 100 yards under, and one for 100 yards over it. A little consideration will show how these results are arrived at even mentally.

The usual practical rule, however, for the use of two elevations is, that one elevation should be for 50 yards under, and the other for 50 yards over the estimated range; and for three elevations, it is that one elevation should be for the estimated range, one for 100 yards under, and the third for 100 yards over it. In the latest German regulations of 1887, it is stated that when the ranges are guessed, and a stationary object is fired at, two sights, differing by 50 mètres will be used for ranges between 400 and 600 mètres; two sights, differing by 100 mètres for ranges between 600 and 800 mètres; and three sights for ranges over 800 mètres; if the objects are moving, then for ranges over 400 mètres, several sights differing, *in the direction of the movement*, by 100 mètres, will be made use of; if the range is known, then two sights are sufficient up to 800 mètres; over 800 mètres, if the range is not known, three sights must be used.

The German regulations of 1879 said:—"The exact range can be demanded from the artillery, if this arm is near at hand, or determined by other means which allow of the distances being appreciated, such as judging by eye, from a good detailed map, &c., &c.

"It is evidently advantageous to know the distance to a yard, but this is not absolutely necessary; generally, it is sufficient to fix the limits between which the objective of the fire lies or is moving. For example, between 500 and 600 yards, or between 800 and 1,000 yards.*

"The correction of the fire by observing the strike of the bullets is only practicable if the ground offers favorable conditions; it succeeds especially with volleys concentrated on the same point.†

"The choice of the sight to be used depends on the degree of inclination of the ground struck by the bullets with respect to the line of sight, on the extent of the ground in depth, and also on the degree of precision with which the distance of the object can be determined, or the limits between which it can be placed.

"Beyond 440 yards the employment of a single sight only promises good results, if the object is stationary, if there is

* But the closer the limits are to one another the better.

† Of course all the men firing for this object must use the same elevation. It is not a question of getting a good length of beaten zone, but of throwing up dust, and for this purpose as many bullets as possible should be projected on the same spot at the same instant.

the time and means to correct the fire, and finally if the configuration of the ground situated in advance of the object is not susceptible of diminishing the efficacy of the fire.

"In every other case, and particularly against objects moving directly to the front or rear, it is, as a rule, necessary to make use of two or more sights, differing by 100 yards from one another. Up to 770 yards, two sights are sufficient; beyond that, three ought to be used.

"When firing at objects moving directly to the front or rear it is necessary to consider, in choosing the sights, the direction of the movement of the object.

"If two sights are employed they will be divided between the front and rear ranks; if three sights are used they will be divided between the three 'züge' of the company.

"It is not advantageous to fire with two or three sights with fractions of troops less than a 'zug' (70 to 80 men) or a company (200 to 250 men) respectively.

"In the choice of the sights to be used, it is necessary to select those which will cause the surface of the ground to be covered with projectiles, to receive a sufficient number of them. For example, if the surface on which the object is, is between 600 yards and 800 yards, the sights to be used are those for 650 and 750 yards; if between 800 yards and 1,200 yards, the sights for 850, 950, and 1,050 yards are to be used."

The French regulations are given on p. 147.

The Austrians say that the combined use of different sights is to be very exceptional, for by so doing, if the object fired at is not of great depth, a portion of the fire is thereby thrown away, and the efficacy of the fire is inversely as the extent of the beaten surface, for a given number of men.

The Italian regulations say that only one elevation is to be used under 500 mètres; if the distance is known and the object is stationary, use one sight up to 800 mètres, and two beyond that distance; if the distances are unknown and the object is moving use two sights up to 800 mètres, and three beyond this range. In this last case the number of sights should be diminished or increased on account of the inclination of the ground, when the length of the beaten zone is increased or diminished more than half of what it would have been on ground parallel to the line of sight. Two sights are to be used by at least a section (50 to 60 men), and three sights by at least a company (200 to 250 men).

A combined use of three elevations is, as a rule, the most that is ever required to be used in practice, *but we ought always,*

when possible, to try and avoid firing under such conditions as require so many sights to be used, from the comparatively great consumption of ammunition which such a use of different elevations must cause, unless very favourable objectives present themselves, and the available supply of ammunition is more plentiful than is usually the case.

The combined use of different sights can also be employed to neutralize the influences of the atmosphere and the nature of the slopes of the ground in the neighbourhood of the object.

The influence of the slopes of the ground, will be pointed out in Chap. XI., but we may here point out the effect of temperature on the choice of sights to be used. In the Belgian experiments of 1883, it was found that the distance of the centres of the groupings of hits made on a horizontal surface, was invariably beyond the object fired at, even with a head wind. This fact was not entirely due to the known tendency that men have of firing too high It was principally due to the temperature, which was about 86° F., while the Belgian rifle was sighted for a temperature of 41° F. only. The consequence was that at long distances, between 1,000 and 2,000 mètres, the difference of 45° F. in the temperatures made the bullets range from 75 to 150 mètres further than desired. Thus, whenever objects without depth are fired on, the temperature must be seriously considered, and the sights either regulated in consequence or multiplied.

We have seen that two or three elevations, used simultaneously, give an effective fire-swept area, having a depth which varies from 200 to 300 yards. It is clear that this result is only obtained with a given body of men at the expense of a diminution of effective fire on any given point of the fire-swept area, and therefore to bring up the effect of the fire it is necessary either to fire more rapidly, so as to burn more cartridges, or to attain this end by increasing the number of men employed, in order to obtain the desired effect without prolonging the duration of the fire. When possible, the latter method is to be preferred, as *prolonged firing ought always to be avoided, in order not to weaken the moral effect which musketry fire ought to produce by means of sudden losses rapidly inflicted.*

The ranges of 400, 800, and 1,200 yards given above for the combined use of 1, 2, and 3 sights respectively, agree very nearly with German practice, and suits the construction of the backsight of the Martini-Henry rifle.

The Germans divide the space which extends between any two hostile forces into three zones*:—

(1) *The short zone*, comprised between the muzzle and a distance of 440 yards (400 mètres),

(2) *The medium zone*, which comprises distances between the short zone and a distance of 770 yards (700 mètres).

(3) *The long zone*, which comprises distances between the medium zone and a distance of 1,320 yards (1,200 mètres).

When the range is not known and has to be estimated by eye, or when one side is in movement, and when the atmospheric influences, and the slopes of the ground near the enemy, are not favourable, the Germans employ, as a general rule, one sight for ranges in the short zone, two sights for ranges in the medium zone, and three sights for ranges in the long zone.

It cannot be too strongly impressed on officers and men, that as the range increases, even when a single elevation only is used, the amount of ammunition expended has also to be increased to get the same results, and that the amount of ammunition to be expended, when two or three elevations are combined, is twice or three times respectively that required for a single elevation, if similar results are required to be obtained.

The following table, taken from the Italian regulations for the Verterli rifle, will bring home to the mind the necessity of employing more men, or of firing more ammunition, as the range increases, to get the same result when using a single elevation only. Taking 1 per cent. of hits as the efficacy to be expected in war, and that at peace experiments ten times better results can be obtained than in war time, that beaten zone is only considered, which, even at its extremities, gives 10 hits. The length of this beaten zone increases and diminishes with the number of bullets fired, and so in order to obtain a constant beaten zone of 100 mètres for use, in the manner shewn above, the least number of rounds are laid down that should be fired at each range to ensure it. "The following table suffices in practice to shew the efficacy of a collective fire, and to approximately calculate the number of bullets necessary to produce a given effect against a given object."

* The Germans consider that the beaten zone of a concentrated fire extends for 100 mètres or 110 yards. If we use this depth instead of 100 yards in the above calculations, we obtain the following distances used by the Germans.

TABLE IX.

Elevation employed. Mètres.	Number of Bullets to be fired.	Length of beaten Zone against Standing Infantry. Mètres.	Hits made.	
			At the ends of the Zone.	At the Centre of the Zone.
400	100	From the muzzle to 450	15	57
500	100	250 from 300 to 550	15	44
600	100	200 ,, 450 ,, 650	10	38
700	100	150 ,, 600 ,, 750	10	28
800	100	150 ,, 700 ,, 850	10	22
900	100	100 ,, 850 ,, 950	10	18
1,000	150	100 ,, 950 ,, 1,050	10	25
1,100	150	100 ,, 1,050 ,, 1,150	10	22
1,200	200	100 ,, 1,150 ,, 1,250	10	22
1,300	200	100 ,, 1,250 ,, 1,350	10	18
1,400	300	100 ,, 1,350 ,, 1,450	10	22
1,500	300	100 ,, 1,450 ,, 1,550	10	20
1,600	400	100 ,, 1,550 ,, 1,650	10	26

N B.—To obtain the same effect against kneeling or lying down infantry, it is necessary to fire approximately $1\frac{1}{2}$ or 4 times respectively, the above number of bullets. Against these objectives, the length of the beaten zone for the 400 mètres elevation, extends only between 200 and 450 mètres.

With regard to the least number of men with whom combined sights should be used, the Germans insist that the body of troops employed should be at least a "zug" (which on a war footing is equal to 70 or 80 men at least, or an average English company), and the Italians say a section of 50 or 60 men, when two sights are used, but both say that a company (200 or 250 men) should be employed when three sights are used. This comparatively great increase of men, is due to the rapid decrease of efficacy of a collective fire as the range increases, as has already been explained. In Germany, when two sights are used, the two ranks of the "zug" each use one, and when three sights are used, each "zug" of the company use one, there being three "züge" to a company.

An English company formed up in two ranks, is subdivided into two half-companies, of two sections each. Hence, when three elevations are to be used, it would be inconvenient to employ an equal number of men to fire with each sight. In this case it would be best to make two sections of the company use the elevation for the presumed range, and the other two sections each to employ, one the elevation for 100 yards over, and the other the elevation for 100 yards under, the supposed range. Or, if it is laid down that when two sights are to be used, a whole English company must be employed, and when three sights, three English companies, then each half-company or company should be made to use one. Each rank should not be given a different sight, as it makes it more difficult to see that the men are using the proper elevation, than if each unit of men used the same one.

The combined use of two sights can easily be arranged for, while that of three sights is much more difficult. But the necessity for the use of three sights at once rarely occurs, and when it does, it is only at ranges over 800 yards, when there is comparatively but little danger or disturbing influences, and when there is ample time to make the necessary arrangements. It must never be forgotten that a combined use of two, and especially of three, sights, would only be made if circumstances required it.

The above rules for the use of combined sights, *with the above strengths of the bodies of men firing*, have been found to give the following result—namely, that the hits from a collective mass fire, executed at all ranges up to 1,300 yards, with a suitable combination of sights and strength of firing body, will always give an effective result of 10 per cent. of the shots fired, against an object anywhere within the beaten zone.

Von Boguslawski and Campe, however, are no warm advocates of combined sights, especially at long ranges, and the latter says "all tricks of fire are opposed to sound tactics. Long range fire with combined sights, as well as indirect fire (see p. 231) only lead, in the open field, to waste of ammunition. These methods, however, may be advantageously used in siege warfare."

In spite of the criticisms of the above well-known German military writers, it is only fair to say that the German infantry do not use a combination of sights when the range is known within 50 yards, when neither opponent is moving, or

when the atmospheric conditions, and the slopes of the ground in the neighbourhood of the object aimed at, are such as only to affect the practice slightly. A proof of the value of combining two or more sights when these conditions are not fulfilled will be given in the next chapter.

The Germans do not question the advantages of accurate aiming, and careful firing, as might be supposed from their use of different sights. The depth of the fire-swept areas would be much more than 100 yards if the men did not aim or fire carelessly (see p. 133). Random firing would, therefore, overturn the whole system of fire which they have adopted.

The French regulations say, concerning the simultaneous employment of several sights:—

"The simultaneous employment of several sights against a single object increases the depth of the ground beaten, to the detriment of the density of the fire, and therefore this method of procedure requires to be used with great discernment. The fire with a single elevation for the distance of the object will always have the greatest efficacy.

"Two sights differing by 100 yards may be used against a moving object or against an object of considerable depth.

"The simultaneous employment of several sights is not admissible by fractions of troops of less strength than 50 men."

The use of several sights doubtless causes an increased expenditure of ammunition to attain a given result, but if it is only calculated to produce a certain percentage of hits it does away with all hesitation and trials in the choice of the range. Ranges, from their great value when known (both in greatly increasing the efficacy of fire and in preventing an unnecessary waste of ammunition) should always be determined by range-finders, or obtained from the artillery when possible, for both methods are far preferable to judging the distance by eye, and if these are not available, the distance judged should be tested by trial *concentrated* fires executed simultaneously, called *volleys*, directed on the object to be hit, and which should be carried out by at least 50 to 80 men, while an observer goes out to one flank to watch the result. The first volley is so regulated as to fall short if possible, and the next one over, and then from the sights used, the approximate distance of the object can be deduced. In the field firing, practiced in Germany, it is, as a rule, necessary to fire 4 to 5 trial volleys to get the range correctly.

But this can only be done if the ground is favourable for it. The concentrated mass of bullets, caused by such a fire, if they strike on a hard, dry, sandy, or dusty surface which can be seen, throw up the dust perceptibly where they fall, and so enable the range to be tested. But if the bullets fall on turf, wet or soft ground, into furze, heath, bushes, or trees, or behind a fall or rise of the ground, or straight into the face of a hill, no dust will be thrown up, and the strike cannot be seen even comparatively close to an observer. Even with a good telescope and on favourable ground the strike of bullets cannot be seen over 1,300 yards, and consequently the elevation cannot be corrected beyond that range.

Another point must be referred to here so as to prevent any misconception of ideas, for, though the reasons for it will be entered into more fully further on, yet the results have already somewhat entered into our present considerations. From the undoubted advantages of a *collective* fire as regards its efficacy and the possible *control* over it, it must be kept up as long as possible; so intimately are these connected that collective firing is only possible so long as control is possible, and the limit of such control with disciplined troops may be put at about 400 yards from the enemy. Nearer than this, and often at a longer range, the men are too much influenced by the moral excitement caused by the enemy's fire, the noise, the cries of the wounded, and the sight of the dead, etc., to be controlled at all, and a rapid independent fire is then involuntarily delivered straight to the front of the extended mass. No order can prevent it. This change from a controlled collective to an independent fire is not sudden, but has been gradually coming on as the power of control has decreased, and must be expected to cease entirely at about 400 yards from the enemy, when the men will fire only to their direct front, and will only be influenced by the training and discipline they have had in their peace training, and by the personal example, and not by the words, of their leaders.

The nearer we are to the enemy the greater will be the effect of a controlled collective fire, but the harder it will be to maintain this control over the men, and therefore to get their fire concentrated on named objectives. Thus these two opposite considerations may be taken as contending for mastery over one another, and experience has shewn that the necessary control of the *whole* body of men in a properly prepared action, can, perhaps, be kept up to about 600 yards from the enemy, and of the smallest fractions up to about 400 yards. But on

the other hand there has been no experience yet of contending troops, each of whose firing has been controlled and concentrated.

The idea of "fire discipline," and the "direction" and "control of fire," has only sprung up since the war of 1870-71, and the necessity for it was still further impressed by the results of the war of 1877-78, in which terrible results were obtained with even no fire discipline, control, or direction, but only by such an extravagant use of ammunition as can rarely be possible.

Complaint may be found with the indefinite conditions that have been arrived at about collective fire, and with the fact that statistical details of results have not been given as for independent individual fire. Here we may add a word of warning from the past. All attempts to lay down definite and absolute data (which, in the first place, a little consideration shows it is impossible to do from the number of counteracting influences) as to the absolute efficacy of the rifle, and then to reason out from this, facts founded on the nature of the arm, has always bitterly failed, as experienced by the losing sides in the wars of 1859, 1866 and 1870, from the indeterminate moral factors, which must so largely enter into calculations of war, not having been allowed for. After 1859 and 1866, theorists laid down that the day of the offensive was past, and that, from the nature of the arms in use, the defensive only could win. How this deduction was realized, in the war of 1870-71, all the world knows.

"The Germans handle with special prudence the data obtained on the practice range, and, thanks to their tactical good sense, they avoid the dangerous path along which those whom they call 'the specialists of the practice range' seek to hurry them. '*Their sound judgment, based on war, has triumphed over the exaggerated speculations of technicalists, and they carefully avoid sacrificing to any formal idea, the very diverse factors which occur in war, and guard against the fault of pushing technical speculations to their utmost consequences.*'"

General Brialmont, very properly writes :—"With regard to the results obtained in peace experiments, we must warn our readers that they notably differ from those obtained in war. Executed generally with skilled firers, disturbed by no emotions, on known ranges, on flat ground, and against fixed targets, which can be distinctly seen, all peace experiments give *maximum* results; very useful, and even indispensable, to appreciate, not the *absolute* value of a fire, but its *relative* value, in comparison with other kinds of fire executed under the same conditions. It is from such a point of view only

that peace experiments have a real importance in practice. They give precise indications on the manner of disposing the troops, and of directing their fire, both in the attack and defence. The officers, charged with the instruction of musketry fire, should always take care to warn their subordinates that the results obtained in peace practices will not be even nearly reached on the battle-field." Thus, *all data should only be looked on as relative*, because it is impossible to obtain absolute figures with regard to the varying circumstances under which infantry fire can be applied. *Having recognised the value of certain methods of proceeding, and decided on them as standards of comparison to go by, all that is of any practical value is to state whether other methods are better or worse.*

The numerical results could be given of many experiments in field firing made in England and abroad, but as it is almost impossible to obtain a full account of the exact conditions under which they took place, and as many of them were carried out before the present system of musketry fire tactics (see Chapter XIV. was instituted, these results are apt to be misleading; and, hence, the Author has considered it preferable to adhere, as a rule, to general statements only.

The results of collective firing should only be regarded as relative data, and the arrangements that we ought to make in action with this kind of fire, should be such as to *get the greatest probable amount of effect in the shortest time possible*, so as to leave as little as possible to chance, and to hasten on a decision as quickly as possible.

One further point must be referred to here with regard to obtaining the greatest efficacy of fire. *A clear uninterrupted field of fire is the first condition.* The possibility of obtaining shelter from the enemy's fire is only a secondary consideration in a decisive action, though its merits may be weighed in a temporising affair. The destruction of the enemy is the principal point aimed at, and, to effect this, the side which hopes for success must be prepared to make the necessary sacrifice of men. *No success in war can be gained without a corresponding sacrifice*, and *omelettes cannot be made without breaking eggs.* This fact must be deeply engraven on the heart of every soldier.

Ricochets from a Collective Fire.*

In Part I. we considered the effects of the ricochets of an

* These remarks are taken from Col. Lamiraux's *Conferences sur le Tir, &c.*

individual fire; now we must do the same as regards collective firing. One of the most interesting points in connection with the production of general effects by fire is that of ricochets. The study of the power of an arm is incomplete without at least a general study of the ricochets it can produce. In the old smooth bore guns the ricochetting power of their spherical shots was, perhaps, the main cause of their efficacy, such as it was, and even now the extraordinary effects of case shot are in a very great measure due to the continued progress of their balls by ricochetting.

Unfortunately, in spite of all efforts to do so, no law can be laid down for ricochets, as they depend on the ground that the bullets fall on, more than on anything else, although the shape of the bullets, the flatness of the trajectory, and the striking velocity, have also some influence in regulating the number of times the bullets ricochet.

The French have made some experiments with the Gras rifle, and obtained the following results for a collective fire directed against an ordinary target placed on a level smooth sandy beach by the sea, *i.e.*, on ground very favorable for ricochets.

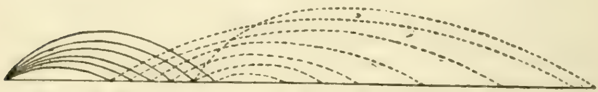
TABLE X.

Distance of Target.	First Zone.		Second Zone.	Third Zone.
	In advance of target.	In rear of target.	Dead ground.	Limit of ricochets beyond the target.
Mètres.	Mètres.	Mètres.	Mètres.	Mètres.
200	—	—	—	1,200
300	—	—	—	1,200
400	75	75	200	1,000
500	75	75	200	1,000
600	75	75	200	1,000
700	75	150	200	800
800	75	100	100	800
900	75	50	100	700
1,000	75	40	100	600
1,100	—	—	—	475
1,200	—	—	—	475
1,300	—	—	—	400
1,400	—	—	—	400
1,500	—	—	—	300
1,600	—	—	—	200
1,700	—	—	—	150
1,800	—	—	—	140

The above peculiar results are average ones only, and are

graphically shewn in the following figures. When the hits were observed on the ground, a zone on which there were no hits, called the *dead ground* above, was always found in firing between 400 and 1,100 mètres. Up to 400 mètres and beyond 1,100 mètres there was no dead ground. Beyond 1,100 mètres the extent of ground beaten by ricochets rapidly decreases as the range increases.

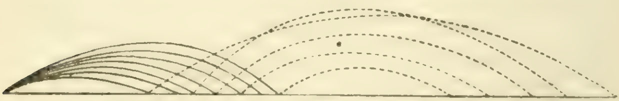
FIRE AT DISTANCES BETWEEN 200 AND 300 MÈTRES.



Cone of Fire. Cone of Ricochets.

FIG. 9.

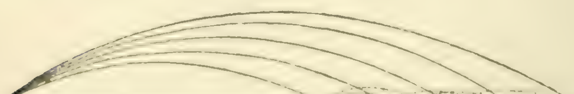
FIRE AT DISTANCES BETWEEN 400 AND 1,100 MÈTRES.



Cone of Fire. Dead Ground. Cone of Ricochets.

FIG. 10.

FIRE AT DISTANCES OF 1,100 MÈTRES, AND OVER.



Cone of Fire and Ricochets.

FIG. 11.

The power of penetration, or killing power, of the ricochets were found to be satisfactory even at the longest ranges.

The French regulations sum up the above results in the following words :—

"When the fire is directed on a hard surface, parallel to the line of sight, the bullets ricochet beyond the first point of impact, provided the range does not exceed 1,900 to 2,000 yards.

"At the shorter ranges under 400 yards the bullets make several successive bounds or ricochets.

"Under these conditions the length of each ricochet is about from 300 to 400 yards up to a range of 400 yards, from 200 to 300 yards up to a range of 800 yards, and from 100 to 200 yards beyond this.

"The bullets in ricochetting deviate laterally, and thus cover a much wider surface of ground than that which is covered with direct hits, but with a marked tendency to carry themselves to the right when the rotation is to the right, (as in the Martini-Henry rifle).

"The width of the ground beaten by the ricochets of a collective fire directed on a single point is about 30 to 45 yards, and it seems independent of the range.

"From the above we see that an object can be hit by bullets falling short, which by ricochetting add to the direct hits.

"The circumstances which appear to give the best results against an object of small depth are those where the densest part of the cone of bullets strikes at the foot of the objective."

Some of these results can be readily deduced from the diagrams of the Dungeness Experiments of 1879-80.

Col. Lamiraux states, that this queston of ricochets was considered in France, as well as that of the flatness of the trajectories in determining the normal sight to be used in battle. In action at close ranges men either do not aim at all or aim badly, and it is only difficult to get them to adjust their sights to the range, and hence it is necessary to determine what single elevation is best for use at all the effective short ranges, in order to ensure some results when the rifles are in the hands of excited men who will not keep adjusting their sights. Taking for granted that the majority of the troops in action will not fire over 600 mètres, it is necessary to determine what single elevation gives the best results between 600 and 700 mètres. The following results of ricochet hits have been obtained in some French experiments.

With the 200 mètres elevation, very bad results.

With the 300 mètres elevation, good results were obtained

at 200, 300 and 400 mètres; at 500 and 600 mètres they were poor, but traces of ricochets which might be effective, were found in advance of the targets up to 150 mètres at 500 mètres, and up to 200 mètres at 600 mètres.

With the 400 mètres elevation, the target was not struck by ricochet hits at 200 mètres, while at 300 mètres they were too few to be considered; very good results were got at 400 and 500 mètres; at 600 mètres the first traces of the ricochets showed that the target would probably be in the safest part of the dead ground.

For these reasons, Col. Lamiraux considers that the 300 mètres elevation is the best for war purposes at short ranges with the Gras rifle.

CHAPTER X.

ESTIMATION OF THE EFFECTS OF COLLECTIVE FIRING.

In this chapter it is proposed to show how the effects of infantry fire have been ascertained, and what these effects are so far as can be made out from peace experiments, and what deductions we may make from them.*

Before going further it is useful to remind the reader that though peace experiments are useful to find out what we can about our weapons, yet all such experiments must be largely discounted by a liberal margin for all those physical and moral causes which tend to disturb a man's mind in action. In most peace experiments the ranges are known; the targets are continuously exposed to a certain amount; no bullets, bursting shells, shrapnel bullets, fragments of iron, splinters, dust, stones, sights of dead and wounded men, cries of pain, sound of passing bullets, &c., disturb the minds of the men firing. It is such things which tell on the *moral* of the men, and it is superiority of *moral* which usually decides victories. If it were not for these disturbing influences on the enemy, we cannot see how, in the face of the results of peace experiments any attack formation could advance over the open. In reality the ranges are imperfectly known, both sides utilise every bit of cover, and the ranges are constantly altering, which theoretically should favour the defenders, who fire from a fixed base, while the forward movement of the assailants renders them unsteady and makes it harder to supply them with ammunition. But the nearer the enemy, the more disturbing is his presence to the defenders, who begin to think that they cannot stop him, while the attacking artillery, being able to approach, fires with more deadly accuracy. It is the difference in *moral* between the attack and defence more than anything else, which enables an attack to succeed, and it is large losses, *suddenly inflicted*, that forms the best and surest way to reduce the *moral* of either side.

* Most of the first portion of this chapter is taken bodily from Nos. 548 to 564 of the *Revue Militaire de l'Etranger* for 1880, and from a digest of them which appeared in Vol. XXVII. of the *Journal of the Royal United Service Institution* entitled, "The Utilization of Rifle Fire in the Field," by Major C. Brooke.

A collective fire ought to be used, as has already been said, when it is no longer possible to rely on the extent of the grazed zones, and when we have to base the probabilities of the results on the depths of the effective dangerous zones.

The fire, the results of which are based on the extent of the grazed zones, is a *fire of theoretical certainty*, that is to say, a fire in which each shot (after deducting anomalous shots) ought to hit if the fire is executed under the conditions required by theory; whilst the fire based on the extent of the effective dangerous zones is *a fire of probability* in which a certain proportion only of the bullets fired normally have a chance of hitting. This percentage will approach the theoretical one, according as we more nearly approach the conditions under which the experimental firing has been executed.

The probable useful effects of a collective fire can be determined, and this has been done in almost all the European armies; but as the experimental firing has not been in all cases executed in identical conditions, there is not, in appearance at least, a perfect agreement in the results obtained. On the other hand, different methods having been used to register the results, the tables of results are not always easily comparable. Thus it is necessary to state the conditions under which any experimental firing has been executed for determining the destructive effects of collective firing and also the methods employed for drawing up numerical and graphical tables for expressing the effects of this fire. It is only after having studied these indispensable preliminaries that we can profitably consider the general observations which an examination of these tables have suggested, the technical interpretation of the results which they contain, and, lastly, the interpretations which have been given to these technical results where they are made use of for improving the methods of using infantry fire.

As regards the objectives that we should choose to fire against in experiments, a French writer says :—" When large objects " are mentioned, such tactical formations will be meant as " may be expected to be seen within 2,500 yards, such as a " company column (of at least 200 men), a battery of artillery " in action, or a squadron. Of course, by accident, a column " of route, or a battalion quarter column, &c., may offer itself " as an objective; but this will be an exceptional case, and " it would not be wise to build up any theories on so narrow " a basis. Further, the results obtained on the above-

"mentioned units will allow us to judge of those which "would be obtained on more extensive formations."—(C. C. J.)

The company columns referred to above are companies formed in columns of sections. Although on the Continent each company is composed of 250 men on mobilisation, yet, after a few days' marching and hard work, their normal strength will be but little over 200 men each.

The German and Belgian companies are divided into three sections of about 70 men each, or 35 files, and the rectangle occupied by the company column in close order is consequently about 23 yards wide by 11 yards deep, each man being supposed to occupy 24 inches in the ranks.

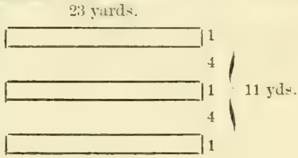


Fig. 12.

The French, Austrian, Russian, and Italian companies are divided into four sections of about 50 men each, or 25 files, and the rectangle occupied by the company column in close order is consequently about 17 yards wide by 16 yards deep.

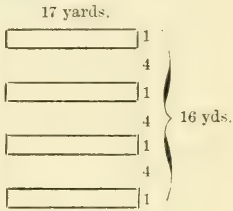


Fig. 13.

There are two ways of obtaining a record of the result of experimental collective firing, depending on the nature of the ground available for the experiments.

1. If the ground is a smooth, sandy flat, so often found on sea shores, then the points of impact of the bullets on the ground can be recorded by marking out the ground in suitable squares. A line of targets is required for aiming at. This is the easiest, simplest, and cheapest way when suitable ground can be found.
2. When such ground cannot be obtained, then any level bit of ground of sufficient length may be chosen, parallel to the line of sight, and a series of vertical targets* erected on it at any convenient distances apart. They are usually placed 10 yards or 10 mètres apart, but to save targets the Germans in

* These targets are made of some light material, covered with paper and stretched on easily movable frames.

their experiments placed each target so far behind the one in front that a bullet grazing the top of this latter would strike the foot of the one behind it; in this case each bullet theoretically leaves but one mark on the entire series of targets. From the vertical record thus obtained, the horizontal representation is easily deduced. From this it is easy also to deduce, by means of the theoretical dangerous zones, what the hits would have been on a series of vertical targets placed at 10 mètres apart. If these targets are the height of a man, then each of them would be hit by all the bullets falling in rear of them to a distance equal to the theoretical dangerous zone for infantry for the range of the target.

We will consider the results obtained by this latter method first. The Germans have carried out a very great number of experiments at their Musketry School at Spandau, to ascertain the effect of collective fire. The fire was conducted by means of volleys fired by men lying down using rests, and at targets 6 feet high, and 20 mètres (22 yards) wide. The number of men firing varied from 10 to 50—as a rule 25 were employed; but the experiments showed that the number has hardly any influence on the results, provided there are at least 10 men firing. The men were extended over a front equal to that of the target (20 mètres), and were ordered to aim straight to their front and at the bottom of the first target of the series.

The results, broadly speaking, have already been given in Chapter IX., but the detailed results are given in Tables A, B, C, and D in Appendices III. and IV.; the target which receives the largest number of bullets is called the "nucleus" of the series.

Table A gives the destructive effect of a collective fire with a single sight against a series of targets 6 feet high and 20 mètres wide, that is against a line of standing men; and also the effect of the same fire on a German company column, standing. This latter effect is obtained by adding the depth of the column to the extent of the theoretical dangerous zone and counting the number of hits in this space.

Table B gives the destructive effect of a collective fire against a series of targets 18 inches high and 20 mètres wide, that is against a line of men lying down, but not under cover; and also the effect of the same fire on a German company column, lying down, which is obtained in the same way as described above.

Table C gives the destructive effect of a collective fire with 2 sights against a target 6 feet high and 20 mètres wide.

Table D gives the number of men's breadths (16 inches) struck by a collective fire with 2 sights.

The data in these tables can be represented by graphical curves, as has been done in Fig. 4, p. 54. These curves are generally used to eliminate anomalies in the table of series if thought necessary. But the Germans appear to prefer leaving the series with all the anomalies that occur in them.

From the above mentioned tables we see that the horizontal grouping of the hits, executed under favourable conditions, presents an elongated surface, over which the hits are spread with remarkable regularity. In the centre of the grouping there is a nucleus rather more dense than at the edges, the hits decreasing from the centre towards the extremities.

The series of numbers given in the tables represent the destructive effects of a collective fire at different ranges.

The length of a series represents the total dangerous ground, and we see that the shorter the range the greater this is.

The sum of the hits in any series exceeds the number of bullets fired, as the same bullet may traverse several successive screens.

Although for convenience the nucleus of a series has been placed at the theoretical distance for the elevation used, yet in reality it was found that up to 700 mètres, the position of the nucleus was at a distance of half the length of the theoretical dangerous zone in front of the target*; this is due to the aim being taken at the foot of the first target of the series. Beyond 700 mètres the nucleus corresponds practically with the object fired at.

The terms of the different series were obtained from a very large expenditure of ammunition, and the series given for the stated number of rounds have been found by simple proportion;

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* The theoretical dangerous zones for the Mauser rifle for 6 ft. targets are as follows :—

75 mètres at	400 mètres		17 mètres at	1,100 metres	
65 ,,	500 ,,		15 ,,	1,200 ,,	
48 ,,	600 ,,		13 ,,	1,300 ,,	
38 ,,	700 ,,		12 ,,	1,400 ,,	
32 ,,	800 ,,		10 ,,	1,500 ,,	
25 ,,	900 ,,		9 ,,	1,600 ,,	
20 ,,	1,000 ,,				

consequently the firing of 100 rounds only may not give exactly the same results, but the approximation will become closer as the number of rounds is increased. At the same time the length of the series will not vary considerably, whether the number of rounds fired be either increased or diminished, provided the number is not reduced below 50, which is the mimimum number required to show clearly the grouping of hits. (See Table XIII, p. 168.)

Hence a collective fire ought to be executed by at least a group of about 10 men (see page 158), firing not less than five rounds each, or 50 rounds in all,—the men using the same elevation and aiming at the same point of the object.

An inspection of Table A, shows us that the number of hits on the nucleus of the series representing the effects of fire against a line of standing infantry for any given range is equal to the number of mètres of the theoretical dangerous zone. (Compare Table A with foot-note on page 159.) Hence when the bullets fall on a surface sensibly parallel to the line of sight the destructive effect in hits at the centre of the ground struck is almost proportional to the theoretical dangerous zone for the object aimed at.

The term "effective dangerous ground" has been applied to that portion of the dangerous ground contained between the first and last screens that receive ten hits. From Table XVIII, p. 203, we see the length, at different ranges, of the effective dangerous zones against a line of standing infantry for a certain given expenditure of ammunition.* Thus up to 800 mètres an effective dangerous zone of 100 mètres is obtained by firing 100 rounds; to obtain the same result between 800 and 1,200 metres, 200 rounds must be fired; and 300 rounds must be expended between 1,200 and 1,600 mètres to get the same result.

The errors of judging distances must not exceed half the extent of the effective dangerous zone, otherwise only a few scattered shots would hit the mark. Thus at 500 mètres an error of 100 mètres would throw almost all the shots off the object, if only one elevation is used.

* Corrected by means of a graphical curve, these effective dangerous zones are as follows: at 400 mètres, 210 mètres; at 500 mètres, 185 mètres; at 600 mètres, 170 mètres; at 700 metres, 150 mètres; at 800 mètres, 130 mètres; at 900 mètres, 115 mètres; at 1,000 mètres, 100 mètres; at 1,100 mètres, 90 mètres; at 1,200 mètres, 80 mètres; at 1,300 mètres, 70 mètres, and at 1,400 mètres, 65 mètres. (Col. Robert.)

This brings us to the consideration of the series of hits obtained by the use of two elevations differing by 100 metres. These have not been determined directly by experiment, but the terms of the two single series for each elevation have been combined together for example : —

TABLE XI.

Part of the Series Representing the Destructive Effects of a Collective Fire Executed with the Elevation of 600 and 700 Mètres, Against a Line of Standing Infantry.

Elevation used.	Rounds.	550	560	570	580	590	600	610	620	630	640	650
Mètres. 600	100	25	35	49	48	49	52	51	47	34	31	24
700	100	..	..	..	..	..	3	4	6	7	14	15
600 & 700	200	25	38	49	48	49	55	55	53	41	45	39

Elevation used.	Rounds.	660	670	680	690	700	710	720	730	740	750	760
Mètres. 600	100	24	16	11	5	3	..	1	2	2	2	1
700	100	19	26	26	29	35	28	33	32	26	29	17
600 & 700	200	43	42	37	34	38	28	34	34	28	31	18

The effective dangerous ground, when two sights are employed, has a greater depth than when only one sight is used, with an equal consumption of ammunition. Thus if 200 rounds are fired at 600 mètres the effective dangerous ground is 180 mètres; but if 100 rounds are fired at 600 mètres and 100 at 700 mètres, then the depth of the effective dangerous ground is 260 mètres. Hence by using two elevations up to 700 mètres, and three elevations up to 1,200 mètres, we can neutralise the consequences of a false estimate of the distance,

of atmospheric influences, and of the slopes of the surface of reception, and thus group the shots around the objective. When the three sights of 1,100 mètres, 1,200 mètres, and 1,300 mètres are used we get an effective dangerous ground of 130 mètres for 300 rounds, and of 300 mètres for 600 rounds. This is for the Mauser rifle only, but with a rifle with a flatter trajectory, the effective dangerous grounds will be greater than the above. The foregoing shows that in long range firing the amount of ammunition must be carefully determined for each case as it arises, and hence the decision as to the employment of this kind of fire must be retained in the hands of the senior officer present.

As a rule it has been found that, when firing 100 rounds, the mean of the number of hits on the screens when two sights are used, does not vary very much from the mean of the number made when only one sight is used, and sometimes even exceeds it, while with a combination of elevation the dangerous ground is doubled and tripled in length, which renders unnecessary such a frequent change of sights; further the extra consumption of cartridges required by a combination of sights is most often compensated for by a percentage which justifies the increased expenditure of ammunition.

The considerations which will be given on p. 198 *et seq.*, as to the influence exercised by the inclination of the surface of reception with regard to the line of sight, will still more strengthen the reasons given to support the practice of combined elevations. With such a combination we can rely, even in the most unfavourable circumstances, on a destructive effect being exercised over a sufficiently considerable depth as will make an effective part of the fire fall on the objective. When we combine the errors of judging distances (12 mètres per 100 mètres) with the deviations due to atmospheric influences, we obtain causes of error which may, in combination, have a considerable influence. They may even be such that, unless we used a combination of elevations, it would be difficult to obtain any satisfactory results, whenever the correction of the fire and the observation of the points of fall are not possible, which, as a general rule, is the case for ranges over 700 mètres, even on the most favourable ground for observation of hits.

As regards this *use of combined sights*, the following statistics are of value. Suppose that the firing is executed against a stationary line of standing infantry at the ranges of 650 mètres and 1,050 mètres, and that the ranges are over- and

under-estimated by 100 mètres, and first one and then two sights are used. The following table gives the results of the fire.

TABLE XII.

Range, in Mètres.	Number of Sights used in Combination.	Percentage of Hits. When range is exactly known.	Estimated range 100 Mètres too much.	Estimated range 100 Mètres too little.
650	1	43·0	3·0	3·5
	2	19·0	7·5	14·0
1,050	1	22·5	1·0	1·5
	2	16·5	4·0	12·5

These figures speak in unmistakeable terms of the value of using two sights *when the object is stationary* and the range is not accurately known, and especially of using sights *for distances under the probable range* by doing which we also gain the effect of the ricochets which fall short.

But the value of using two elevations in combination against a *moving object* is not quite so conclusive. This has been pointed out by a Belgian writer in the *Revue Militaire Belge* for 1881. Suppose an enemy to leave cover at a range of 750 mètres and to advance to 550 mètres, and that during this movement four volleys are fired on him at the ranges of 700, 650, 600 and 550 mètres, by a given number of men.

Case 1.—Now suppose the ranges are known, then, using the data given in Tables A and C, if the true elevation for each of these ranges is used the mean percentage of hits is 47; and if two sights are used (for 50 mètres above and below each of these ranges) at each of these distances, the mean percentage is only 22. Showing that when the true elevations are known, no advantage is gained by using two elevations, which is self-evident. If only the 600 mètre elevation is used on the whole space, the mean percentage is 26; with the 650 mètre elevation used in the same way, the mean percentage is 23. If the two elevations for 600 and 700 mètres are used in combination over the whole distance the mean percentage is 19·6; and the mean percentage is 23·3 for the two elevations for 550 and 650 mètres; and it is 18·6 for the two elevations 500 and 600 mètres, used in the same way.

From this we see that next to using the true elevation for each range, the best result on a moving object is gained by the use of the 600 mètres elevation, over the whole space, *i.e.*, the elevation for one of the shorter of the known ranges. We also see that when two elevations are combined much the same results are obtained, whether they are adjusted to the range or not, when the ranges are known.

Case 2. Now suppose that the ranges have been over-estimated by 100 mètres; that is to say, we want to ascertain what the effects are at the ranges of 700, 650, 600, and 550 mètres, while using the elevations for 800, 750, 700, and 650 mètres. Now if the sights are adjusted for each of the supposed ranges, the mean percentage is 3; and if two sights are used at each of the supposed ranges, the mean percentage is 6·6, a clear gain of double the number of hits. If only the 700 mètres elevation be used on the whole space, the mean percentage obtained is 13·3; and if the 750 mètres elevation is so used the mean percentage is 4·3. If the two elevations for 700 and 800 mètres are used over the whole space, the mean percentage is 7·0; and the mean percentage is 13·6 for the two elevations of 650 and 750 mètres, and it is 19·6 for the two elevations for 600 and 700 mètres used in the same way.

Here again we see that the use of one elevation for one of the shorter of the supposed ranges gives the second best result, *when the ranges are over-estimated.* The best result is got by the combined use of the elevations for 600 and 700 mètres over the whole space, *i.e.*, elevations for the shorter ones of the supposed ranges.

Case 3. Now suppose that the ranges have been under-estimated by 100 mètres; that is to say, we want to ascertain what the effects are at the ranges of 700, 650, 600, and 550 mètres, while using the elevations for 600, 550 500, and 450 mètres. Now if the sights are adjusted for each of the supposed ranges, the mean percentage is 8·5; and if two sights are used at each of these supposed ranges the mean percentage is 14·8, a clear gain. If only the 500 mètres elevation is used over the whole space, the mean percentage is 11·3; and if the 550 mètres elevation is so used, the mean percentage is 23·5. If the two elevations of 500 and 600 mètres are used over the whole space, the mean percentage is 18·6; and the mean percentage is 13·4 for the two elevations of 450 and 550 mètres; and it is 6·5 for the two elevations of 400 and 500 mètres used in the same way.

In this case we see that the elevations single or combined for the shorter of the supposed ranges, do not give the best results *when the ranges are under-estimated.* The best results are got at the longer of the supposed ranges.

Now as we have no means of telling whether we have over - or under-estimated our ranges, the Germans have decided on using combined sights adjusted in the manner already described to the supposed range. By this a low, but almost certain mean percentage of hits is obtained. Any other method might, perhaps, get higher results, but then it is equally likely not to obtain any results at all.

The representative series of the German tables have been deduced from firing, executed under very favourable conditions; consequently it would be difficult, even in many peace exercises, realise the results they show. *We ought to consider these series as the ideal expression of the effects that it is possible to obtain on a level surface sensibly parallel to the line of sight*, because they undergo considerable changes when circumstances differ from those under which the experimental firing was carried out.

Hence it is necessary to consider, in a general manner at least, the nature of the changes which these ideal series undergo when the conditions of firing are changed, and also in the following cases :—When the men are less skilful than those who executed the experimental firing; when the rifle is more or less accurate, and its trajectory has more or less flatness than that of the Mauser; when the method of fire employed is other than volleys fired from supports; when a different attitude is used to that of lying down; and lastly when the bullets fall on a surface inclined to the line of fire.

The dimensions of the shot groupings of a collective fire from several men and rifles are far greater than those of an individual fire from a single rifle, partly from the differences which exist between rifles of even the same pattern, and partly from the differences made in aiming by different men. This last source of dispersion of the shots has been found to be as much as 30 minutes of elevation for the Mauser. At the shorter ranges (up to 1,000 mètres for the Mauser) the dispersion due to the differences in rifles is greater than that due to differences in aiming, but at longer ranges the reverse takes place. In comparing the relative values of two different types of rifles, we must consider this source of dispersion in addition to their respective accuracies, and the flatness of their trajectories. Thus it is not sufficient to study separately the causes of deviation. A rifle *A* may give shorter beaten zones

than another kind of rifle B, but B may have a flatter trajectory than A. Then the density* of the hits from A will be greater than that of B; but as the dangerous zones of B are greater than those of A, the destructive effects of B may be the greater of the two, as the destructive effect is equal to the density per unit of length multiplied by the length of theoretical dangerous zone† expressed in the same units.

This shows that in estimating the value of different rifles it is not only necessary to compare the flatness of their trajectories and the accuracy of their shooting, but it is also necessary to compare the extent of the spread of the bullets when a dozen or more rifles of the same pattern are made use of in collective fire. The pattern of a rifle which, under these circumstances, gives rise to a denser and more regular grouping of hits will be the best, and have the most destructive effect in the field. There is no method more searching for testing the value of different patterns of rifles than the rigid comparison of the series of terms obtained from long continued collective firing.

A study of the representative series proves that *skill in firing is shewn just as much in collective firing as in individual firing*, and also we see from the series that *we commit a fault when we attempt to judge of the skill of a body of men, at distances over* 400 *yards, by its fire at a single target.*

If the men, though still firing from a rest, are less skilful than those by whose fire the representative series were obtained, and make errors of elevation in excess of 30 minutes, the series will be lengthened and the shots in the nucleus and in the adjoining screens will be less dense; and further, the series will be less regular in character. By employing men still less skilful in firing, all these irregularities will be accentuated, and it may happen that gaps will appear in the series in the neighbourhood of the distance corresponding to the sight in use. Hence to obtain the same result from skilful and unskilful men the latter must fire more ammunition.

When the firing takes place *without rests* the series is much lengthened and becomes irregular, the destructive effect of the fire ceasing in some places. These gaps are more numerous and occur nearer to the distance corresponding to the sight used in proportion as the inaccuracy of the fire

* The density here meant is the number of hits divided by the dangerous zone expressed, say, in yards. By this we get the density per yard of dangerous zone.

† The theoretical dangerous zone for infantry is equal to six feet, divided by the tangent of the angle of drop.

increases. It is for this reason that the Germans insist on the necessity for firing from rests over long ranges. This also proves *the incorrectness of the statement that collective fire is the negation of all musketry instruction.* On the contrary, the representative series show, by the modifications they undergo when deduced from the firing of bad shots, that *the training and careful instruction of the soldier is as necessary and has as much influence in collective firing as they have in individual firing.* The skill of the firers is so much the greater as the record of their shooting gives a more regular, more continuous and denser series. From this it follows that *the collective fire of several men at a single target at distances over* 400 *yards is not the true gauge of their effiicency. It is necessary that they fire at such a series of screens as will register all the hits*; then from the density and regularity of the series an estimate of the value of the shooting can be obtained, for the position of the nucleus offers no clue for this purpose, as it does not depend on the efforts of the men, but on factors beyond their control. In fact, the nucleus, as a general rule, does not coincide with the engraved range corresponding to the elevation used.

For instance, atmospheric conditions have their influence on the firing. The Mauser rifle is sighted for a temperature of $2\frac{1}{2}°$ C (35° F), and a lower temperature than this would cause the series to be less dense than the normal one, while a higher one would make the series denser. An atmosphere more or less warm makes the whole series respectively advance or retire with reference to its normal position. Between $+3°$ C and $-3°$ C, a fall of temperature displaces the series towards the firing point as much as 12 mètres for each fall of 1° C for ranges between 400 and 1,200 mètres; on the other hand a rise of temperature between 3° C and 15° C (58·5° F) removes the series further away as much as 4 mètres for each rise of 1° C for the same ranges. The hygrometric state of the air sometimes counterbalances this increase of range, for when the ground is much heated by the sun, the most densely saturated layer of air is at a certain distance above the ground, and consequently acts as a retarding force more powerfully on high trajectories than on low ones. Also an elevation of temperature tends to neutralise the bringing of the nucleus towards the firing point at ranges under 700 mètres caused by aiming at the foot of the target (see p. 159).

Any irregularity of the series, due to want of skill in the men firing, may be neutralised by firing a greater number of cartridges. Also if fewer rounds are fired then those given in

TABLE XIII.

Number of rounds fired.	470	480	490	500	510	520	530	540	550	560	570	580	590	Nucleus. 600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760
100	1	4	4	4	11	17	21	23	25	35	49	48	49	52	51	47	34	31	24	24	16	11	5	3	—	1	2	2	2	1
50	—	2	2	2	5	8	10	11	12	17	24	24	24	26	25	23	17	15	12	12	8	5	2	1	—	—	1	1	1	—
25	—	1	1	1	3	4	5	5	6	8	12	12	12	13	12	11	8	7	6	6	4	2	1	1	—	—	—	—	—	—
10	—	—	—	—	1	1	2	2	2	3	4	4	4	5	5	4	3	3	2	2	1	1	—	—	—	—	—	—	—	—

the tables, not only are the irregularities of the series accentuated, but the effective dangerous grounds become almost insignificant in length. This is shown in Table XIII. on previous page, which indicates the different series for 600 mètres, when 10, 25, 50, and 100 rounds are fired against a line of standing men.

With 50 cartridges the effective dangerous zone is still 130 mètres, but with 25 cartridges it is reduced to 50 mètres.

When a type of rifles has *a great accuracy*, the representative series of its destructive effects are very regular in the increase and decrease of the terms of the series; further, the hits on the screen forming the nucleus and on the adjoining screens are denser than for a type of rifle having a smaller accuracy.

The greater *the uniformity of manufacture* the smaller will be the length of the series.

The flatter the trajectory the more hits there will be on each screen, and the longer will be the whole series.

When *mass firing* (see p. 384) is used instead of volleys, a rather less regular and longer series is obtained, although the hits on the screen forming the nucleus and on the adjoining screens are a little denser. This tends to show that volleys are preferable to mass firing at long ranges. But when a sufficient number of pauses are made to allow the smoke to dissipate, mass firing gives much the same result as volleys. At the short ranges, however, mass firing gives a shorter series with a higher nucleus than volley firing, and this is why the Germans favour intermittent mass firing. Besides increasing the precision of the fire, an intermittent fire further restrains those who have a tendency to prematurely expend their cartridges, and it thus concurs in ensuring fire discipline. An intermittent fire is also an excellent means of giving to the fire the great effects of suddenness and power which corresponds to the needs of all modes of attack and action.

As has been said before, the *number of men* firing has no notable influence on the results, provided there are at least 10 men firing.

For practical purposes the following table, taken from the German Musketry Regulations, and based on the German experiments already given, shows sufficiently the relative proportion of losses between the line and column formations, lying down and standing, and gives sufficient data for ascertaining the desirability or otherwise of opening fire.

TABLE XIV.

(*N.B.—The Prussian Company Column referred to has 250 men.*)
(See page 157).

Back-Sight set for	Depth of Dangerous Zone covered by the Projectile.	Percentage of hits on targets representing. Men erect, 6 feet high. In Line.	Men erect, 6 feet high. In Company Column.	Men lying down, 1ft. 6 in., or ¼ height of men standing. In Line.	Men lying down, 1ft. 6 in., or ¼ height of men standing. In Company Column.	Number of Bullets Fired.	Number hit out of 50 upright men extended at equal intervals over a front of 110 yards.
Mètres. 400	From Muzzle up to 450 mètres.	p.c. 50 to 70	p.c. 60 to 80	p.c. 15 to 20	p.c. 25 to 30	200	35 to 41
500	100	30 to 60	40 to 65	6 to 18	15 to 30	200	25 to 38
600	100	25 to 50	35 to 60	5 to 15	15 to 30	200	25 to 38
700	100	18 to 35	30 to 45	4 to 10	12 to 25	200	20 to 35
800	100	15 to 30	20 to 40	3 to 9	6 to 19	200	12 to 33
900	100	10 to 25	15 to 40	2 to 8	6 to 18	300	20 to 35
1,000	100	7 to 20	15 to 35	1 to 6	6 to 15	300	15 to 35
1,100	100	6 to 17	15 to 30	1 to 6	6 to 15	300	15 to 28
1,200	100	5 to 15	10 to 27	1 to 4	5 to 14	300	12 to 25
1,300	100	4 to 12	10 to 22	1 to 3	4 to 8	—	—
1,400	100	4 to 10	10 to 14	1 to 3	4 to 8	—	—

From this table we see that up to 770 yards, the Prussian company column (of 250 men) lying down will suffer, on an average, at all ranges, 2 or 3 times as much as a company in a line lying down; and that the company column standing up suffers but little more loss than the company in line, but beyond that distance its losses are more than double that of the line.*

This last deduction seems on the face of it to be wrong; General Brialmont states it is wrong, and he made some experi-

* The Austrian Experiments show the same.

ments which confirmed his views. The results he obtained were that when 180 men advanced from about 400 yards to about 60 yards while firing, the losses of a company column were at the least double those of a company in line. This seems much more in accordance with war experience, because from the above table, columns of attack could be used under fire, while numerous cases could be quoted from the wars of 1870-71, and 1877-78, to show that neither such columns, nor any closed formation, can exist under modern fire, unless the enemy has been so demoralized as to fire very wildly and high. In proving his case General Brialmont points out that the bases on which the Germans worked out their percentages were wrong, as they have not allowed for the fact that in a line formation after the first hits have been made, gaps are formed, through which the succeeding bullets pass harmlessly, while in a column formation, bullets thus passing through the leading echelon, will strike those in rear.*

The losses of an extended firing line, in any attitude are less than that of a closed line in the same attitude, and will vary proportionately to the density of the firing line.

To be on the safe side we should take the minimum percentages given in Table XIV. Both the French and Germans consider that only one-tenth of the results obtained in peace can be counted on in war, and the French further think there is a waste of ammunition, unless a loss of 10 per cent. in peace time (or 1 per cent. in war) can be inflicted.

The French experiments made in 1879 at the camp of Chalons, *over measured ranges*, also showed that of all formations of closed ranks the line formation is least vulnerable. The results are tabulated as follows:—

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* A German officer commenting on this statement writes: "The "results of our (the German) experiments, are quite different to those "obtained by General Brialmont, but ours are confirmed by the Russian "experience at Lovtcha. General Brialmont fired against a company "column which had no skirmishers in front, so that the men could see the "column quite distinctly. The case is different if a company column is "advancing behind a line of skirmishers and screened by thick bands of "smoke covering the whole front." Certainly in General Brialmont's experiments, the fire was concentrated on the column, but the experience of the Franco-German war seems to corroborate his conclusion, for in that war it was found impossible to bring up any columns under fire into the firing line.

TABLE XV.*

THE PERCENTAGES OF VULNERABILITY OF A CLOSED LINE OF 200 MEN 2 DEEP, AND OF A COMPANY OF 200 MEN IN COLUMN OF SECTIONS. (*See p.* 157.)

Distances.	Upright position.		Kneeling position.		Lying down position.	
	Line.	Column.	Line.	Column.	Line.	Column.
Mètres.						
1,000	20·0	33·0	12·5	25·0	6·2	20·0
1,100	14·2	25·0	9·0	20·0	4·5	16·6
1,200	11·0	20·0	7·1	16·6	3·5	12·5
1,300	8·3	16·0	5·2	12·5	2·6	9·0
1,400	6·6	12·5	4·1	10·0	2·0	5·8
1,500	5·2	10·0	3·3	8·3	1·7	4·3
1,600	4·1	7·6	2·5	6·2	1·2	3·2
1,700	3·2	6·2	2·0	4·7	1·0	2·4
1,800	2·7	5·0	1·6	4·0	0·8	1·8

From this table we see that:—

1. A company (250 men) in line formation, with respect to vulnerability, is always preferable to the formation of company column of sections.

2. That this advantage shows itself more strongly in the lying down position according as the range decreases, whilst the proportion of vulnerability in the upright position remains almost the same.

For example, if the vulnerability of the line formation is represented by 1, we have for the lying down position:—

Ratio of vulnerability between the two formations at 1,800 mètres $= \frac{0\cdot8}{1\cdot8} = \frac{1}{2\cdot2}$.

Ratio of vulnerability between the two formations at 1,000 mètres $= \frac{6\cdot2}{20\cdot0} = \frac{1}{3\cdot2}$.

There is a good difference between these ratios.

* General Brialmont's objections, given above, apply here also. According to him, the losses of the line would be less than half of those stated in both tables.

For the upright position we have:—

Ratio of vulnerability at 1,800 mètres$=\frac{2\cdot7}{5\cdot0}=\frac{1}{1\cdot8}$.

Ratio of vulnerability at 1,000 mètres$=\frac{20\cdot0}{33\cdot0}=\frac{1}{1\cdot6}$.

These ratios are almost equal.

"The tables of the French Committee on infantry fire, on the vulnerability of tactical units, are very exact on the practice ground; but these tables have been obtained with soldiers who have been well placed, well directed, perfectly trained, and having absolutely no danger to fear; that is to say, with men placed in conditions which it is impossible to obtain under the fire of an enemy." So that these tables can only give relative and not absolute results.

With regard to the chance of hitting different formations in open ground parallel to the line of sight, the French regulations say that, "Within 440 yards, a kneeling man is not much less hard to hit than a standing man.

"Between 440 and 880 yards, the possibility of hitting a line of skirmishers is sensibly proportional to the surfaces exposed to the fire, and the amount of loss it experiences depends on the density of the line.

"A line of groups of two men each side by side, is more easy to hit in all cases than a line of corresponding density having equal intervals between the men.*

"The vulnerability of a closed squad will, as a rule, compel them to deploy as skirmishers when they are from 660 to 880 yards from the enemy.

"Under 440 yards, deep formations are very vulnerable, even when they only present a weak front.

"Between 440 and 880 yards, and especially at longer ranges, objects with a small front are hard to hit, because of the lateral deviation which atmospheric circumstances may impart to the projectile.

"Lines with a long front allow of an easy correction of the fire in direction, but over 880 yards, their vulnerability is small because of the small extent of the dangerous zones.

"The vulnerability of a line diminishes very rapidly with the distances, and almost in the ratio of the dangerous zones; beyond 660 yards, it is sensibly proportional to the height of the object.

"Column formations of a considerable front (such as company columns of 200 to 250 men each) form very vulnerable objects and facilitate the correction of fire in direction.

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* Because groups of 2 men offer a broader and more definite point to aim at.

"Over 880 yards the company column is on an average twice as vulnerable as the company in line.

"The vulnerability of deep formations does not decrease as rapidly as that of a line, as the distance increases; it depends on the number of sub-divisions forming the column and the dangerous zone for the distance considered. Over 880 yards the vulnerability of closed columns remains sensibly the same whatever be the attitude of the men, standing, kneeling, or lying down.

"The increase of range of modern arms, condemns the use of deep formations within ranges at which they are vulnerable, but it does not authorize fire being opened at too great distances."

We must also always bear in mind that it is *the density of the formation, line or column, which is one of the greatest causes of loss.* As the heights of the objectives in war are fixed quantities, *the depth and not the breadth of a formation has most effect on the consequent losses,* as the depth of the different dangerous zones are far greater than their width, which latter quantity is governed by the width of the shot-groups only.

The superiority of line over column formations under fire is thus undoubted as regards vulnerability, and we see they must also be so as regards superiority in execution of fire. The advantage of column formations is in facility of marching and control, but as soon as the effects of fire become sensible this consideration must give way to that of the preservation of the men, not for their own sakes, but for that of the object in view. It is admitted as a principle in France, that as soon as a formation may be expected to suffer on the practice range a loss of 10 per cent., it must be modified in such a manner as to reduce the losses, so that by the application of this principle, the formation of company columns (of 200 men) ought to be abandoned in open ground, if the enemy knows the range, at 1,500 mètres (see Table XV.) and be replaced by the line formation, but as a line formation for a whole company of 200 men is too clumsy for marching, a line of sections in line, with intervals (of a section as a rule) must be used. Then at 1,200 mètres another disposition is required, because the sections in line then begin to suffer a 10 per cent. loss. This is a theoretical statement, for it supposes the ranges to be known and the troops unexcited by an enemy's fire, neither of which conditions exist in war, but the French say it is a maximum result which must be

allowed for. *In reality, troops even on the defensive will rarely open fire over* 800 *yards, except at large objects of considerable depth.*

All the above figures, both in the German and French experiments, show that both *the height and depth of an object fired at are more important than its breadth;* by the German experiments, at the longer ranges, the losses suffered in the column formation are twice as much as when the men are in line, and when the men are lying down in line their losses are about one-fourth those when standing in line, and when lying down in column formation about twice less than when standing in column.

From this we see that cavalry, which has a greater height than infantry, will suffer more than these latter at all ranges, and hence fire may be opened on them at longer ranges.

With regard to artillery, in 1878, in Austria, a company of 211 infantry fired at 1,500 yards (*the range being known*), at targets representing three guns in action with their detachments. Ten rounds were fired by each man in $3\frac{1}{2}$ minutes. 189 balls, or 9 per cent. struck the targets, or, in other words, the guns were silenced in $3\frac{1}{2}$ minutes, the whole of the 108 men forming the *personel* being hit within that time. At 1,000 yards they obtained 11·5 per cent. of hits.

In France also, it has been found that if a company (250 men) of infantry succeed in creeping up to within 1,500 yards of a battery of artillery, (*the range being known*,) the horses and men would all be disposed of in a very few minutes.

Such experiments tend to show that artillery will suffer sensible losses at 1,200 yards at least, instead of 800 yards, which, up to late years, was considered the limit of the effective range of infantry fire.

The range therefore at which fire may be opened on an enemy with advantage depends greatly on the enemy's formations and as to whether the objective is infantry or cavalry.

Let us see how the results given can receive a practical application.

The percentage of hits are sufficient for comparisons between the results that may be expected from a fire directed on different objectives. But as it does not matter if an enemy is struck by one or many bullets, consequently the only data of any practical value to us are those by which we can say, "If we fire so many shots, depending on the range, we shall put so many of the enemy out of action." From Table XIV. we see that if we fire 200 rounds at 700 mètres at a standing line of 50 men in close order we shall put 20 to 35

out of action. Let us take the worst case and say 20. Suppose now a company of 200 men are firing against a company of equal strength and we want to know how many rounds are required to hit half of the enemy, that is to say, 100 men, when they are standing in close order line in the open. In firing one round per man, 20 of the enemy are hit; consequently to hit 100 men, 5 rounds per man must be expended, or 1,000 in all. If the enemy is lying down in line, then four times this number is required. If the enemy is standing and is widely extended, then perhaps only one will be hit for every 100 rounds fired, and to hit 100 men 10,000 rounds must be fired or 50 rounds per man.

But we shall be suffering losses ourselves, and, if this be considered, it will not be too much to say that we may have to fire 70 to 80 rounds per man to obtain the above result, that is to say, the whole supply carried by each soldier.

Such is the manner in which we can calculate, from the data obtained from experiments, the expenditure of ammunition neçessary to obtain certain results on any given formation. The losses of kneeling position are one-half those for standing positions, and the losses of the lying position are one-fourth those of the standing position. According as the men in a firing line is extended 2, 3, 4, &c., men's breadths apart from centre to centre, 2, 3, 4, &c., times respectively the amount of ammunition must be fired to get the same result. But as it is impossible to remember the data for all ranges, they should be remembered for the standard ones of 400, 800 and 1,200 yards or mètres.

We must now consider the first of the two methods given on page 157 for obtaining a record of the effects of collective firing, namely that of marking out a flat piece of ground* in suitable squares, and transforming the hits on to a corresponding paper diagram. In this manner an exact representation of the horizontal grouping of the hits is obtained. This method has been largely used in France, and to some extent in England, in the few experiments we have carried on in collective firing.

Given the graphical representation of the horizontal grouping of the hits, it is easy to determine the hits on any objective, by drawing to scale a rectangle whose length is equal to the front of the objective, and whose depth is equal to the depth of the objective increased by the theoretical dangerous zone for the range and for the height of the objective. The number of hits included in this area gives

* The ground should be at least 600 yards long by 150 yards wide.

the hits on the object fired at. The hits in an extended firing line will be the same as those on a single man. If the fire is directed on an open column, and if the distance between the successive parts of the column is greater than the theoretical dangerous zone, then each section must be treated isolatedly as if it was a single line.

Another way of finding the vulnerability of any formation when its width is less than that of the dangerous zone, is to ascertain the density of the hits per square yard over the beaten zone, then if N be the total number of hits per square yard; S the area over which they fall in square yards; Z the length of the theoretical dangerous zone in yards of the mean trajectory for the range; L the length of the front of the formation, and

D is depth, then $\dfrac{N}{S}$ = the density per square yard and the

$$\text{vulnerability of the formation} = \frac{N}{S} \times L\,(Z + D).$$

If the formation has a greater width than the effective dangerous zone, then we may use the density of hits per yard of depth of the effective dangerous zone and, the formula for the vulnerability becomes $\dfrac{N}{E}\,(Z + D)$ where E is the depth of the effective dangerous zone.

The Belgians in 1881 tested the value of this last formula and found it to agree very exactly with experience. General Brialmont and Commandant Paquié asserted that the efficacious zone, containing 50 per cent. of the hits, was 150 mètres between 500 and 1,000 mètres, and 100 mètres for ranges over 1,000 mètres and up to 1,800 mètres. This statement was tested and found to be the case, taking the averages.

Commandant Paquié also asserted that the hits in the efficacious zone are uniformly distributed in the direction of the depths of the zone. If this is the case, then the density of hits per mètre for ranges under 1,000 mètres is $\frac{50}{150}$ or $\frac{1}{3}$ per cent.; and for ranges over 1,000 mètres it is $\frac{50}{100}$ or $\frac{1}{2}$ per cent.; and from this it is easy to determine *à priori* for any given distance, the losses that can be inflicted on any formation whatever, which would be of the utmost value to officers charged with directing the fire in action.

Thus if the theoretical dangerous zone for standing infantry is 15 mètres at 1,200 mètres, then a stationary close line of

standing infantry ought to receive at that distance 15 × ½ or 7½ per cent. of the bullets fired.

If the objective is a column formation, the depth of the column must be added to the theoretical dangerous zone, that is to say, if the distance between the elements of the column is less than the theoretical dangerous zone, and the total depth of the column does not exceed certain limits. Thus if the objective is a line of close company columns of sections* (9 mètres in depth) then the percentage of hits on it should be at

$$1{,}200 \text{ mètres } \frac{15 + 9}{2} \text{ or 12 per cent.}$$

For distances under 1,000 mètres we must divide by 3 in the above cases.

The experiments to verify these conclusions were made with targets 5 feet 8 inches high, and representing a line of standing infantry. The last column of the following table gives the percentages obtained by experiment, to compare with the column before it.

TABLE XVI.†

Range in Mètres.	Theoretical dangerous Zones, in Mètres.	Calculated p.c. of hits on a column of Sections.	Company in Lines.	
			Calculated p.c. of hits.	Experimental p.c. of hits.
400	129	46·0	43·0	—
600	61	23·0	20·3	18·0
800	34	14·3	11·3	10·4
1,000	22	12·9	9·1	9·6
1,200	15	12·0	7·5	8·3
1,400	11	10·0	5·5	5·4
1,600	8	8·5	4·0	4·0
1,800	6	7·5	3·0	—
2,000	5	7·0	2·5	-

* There are three sections in a Belgian company.

† The percentages for the 1,000 mètres range are found by dividing by 2·5 the mean of 3 and 2.

From this it appears that at 400 mètres the company column (formed of three sections with a depth of 9 mètres) suffers almost as much as the company in line; but as the distance increases the column suffers more losses relatively, namely, twice as much at 1,400 mètres, and three times as much at 2,000 mètres. This conclusion, however, supposes that all the front of the company column (25 mètres) is greater than that of the dangerous zone; this is almost the case up to 1,200 mètres, but not so over that distance; consequently the above percentages for the company column are too great at ranges over 1,400 mètres. This was confirmed by experiment. Further if there are any intervals between the men in a line, the proportion of the intervals to the front must be deducted from the percentages of the line.

Experiments were made to test General Brialmont's statement in his "*Étude sur les formations de combat de l'infanterie*," that "from 600 to 1,200 mètres, the chance of hitting a deployed squad of 14 men (8 mètres), or a company formed up in two ranks (48 mètres) was the same." The experiments were very incomplete, but, as far as they went, they showed that this was not the case. Targets were used representing the fronts of a demi-section (12 mètres), of a section (24 mètres), of two sections (48 mètres), and of a company (72 mètres), and the results showed that though these units were equally vulnerable at 400 mètres, yet, as the range increased, the smaller the unit the less it suffered. At 1,000 mètres, the vulnerability of the two sections was 0·97; of the section, 0·84; and of the demi-section, 0·60 of that of the company.

The above considerations form excellent data by which officers can guide themselves in directing fire in the field; they can only be considered as an approximative basis, it is true, but they suffice to form an idea of the losses that can be inflicted on any particular formation when once the proper elevation to be used is known. The same principle can be applied to men in extended order, and in any of the attitudes of standing, kneeling, or lying down.

In firing against a battery of six guns, placed at 12 mètres apart, with the limbers 20 mètres in rear of the guns, and with targets representing the men and horses, the following percentages of hits were obtained, on the men and horses only, by 120 men, each firing 10 rounds by volleys:—At 1,200 mètres, 10·5 per cent.; at 1,400 mètres, 8 per cent.; at 1,600 mètres, 4 per cent.; and at 1,800 mètres, 2·3 per cent. The percentage of hits on the men, horses, and *materiel* :—At

1,200 mètres, 12 per cent.; at 1,400 mètres, 8.5 per cent.; at 1,600 mètres, 5·0 per cent.; and 1,800 mètres, 3·8 per cent. This shows that *when the proper elevation for the range is known*, artillery can seriously suffer from infantry fire at 1,200 mètres, if the battery is not covered by epaulments.

Similar experiments against a battery were carried out in 1883, with the same results. In these trials, the employment of three combined elevations were used, when the ranges were guessed, and the results obtained were rather greater than one-half those obtained with one elevation, with known range, *especially when the fire was rather short.* This effect is evidently due to the effective action of ricochets.

This superiority of results, from an under-estimation of the range, was noted throughout all the Belgian experiments of 1883, and points to the fact that *it is better to under-estimate than to over-estimate the ranges.**

With regard to *the effect of fire on various formations*, the records procurable of the Belgian experiments are not so complete as those of the French experiments made at Chalons in 1876. Statistics of these are given by Captain Bazin and Colonel Lamiraux, but those given by the latter officer show lower results than those given by the former, on account of their including trials made at unknown as well as at known ranges, and in the volley and mass firing. Captain Bazin's statistics have been chosen as giving the maxima, or ideal results that it is possible to obtain.

The units fired at were of various sizes, in line and column formations, and in column by a flank. The company column has been described on page 157. The half company column (*le demi-colonne de compagnie*) is composed of two sections in column at a distance of 5 yards apart. It contains only half the number of men that the company column and column of half-companies do.

The following data, found in 1876, do not quite agree with those found in 1879, given in Table XV, p. 172.

* The Germans have evidently arrived at the same conclusion—see the German rules for the employment of sights, given on p. 78.

TABLE XVII.

Distances.	Line formations.					Column formations.			Column of route or of marching to a flank in fours.							
	Squad 15 men	Half section 30 men	Section 60 men.	Half-company 120 men	Company 240 men	Company column of 4 sections	Half company column of 2 sections.	Column of half-companies.	Squad.	Half section.	Section.	Half-company.	Company.	Company column	Half company column	Column of half-companies.
m.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.
500	36·0	50·0	60.5	65·0	68·3	71·4	64·1	68·9	12·4	13·3	15·0	17·8	24·0	40·4	24·4	32·4
600	24·8	37·3	45·1	49·2	52·2	56·4	48·7	53·1	8·3	9·1	10·2	13·2	18·3	35·0	18·3	27·8
700	21·9	30·0	38·3	42·2	44.1	50·9	42·4	46·8	5·1	6·0	7·1	10·0	14·3	30·1	15·2	23·0
800	15·2	22·3	29·0	33·1	35·0	41·5	33·3	38·0	3·0	3·8	4·3	7·2	11·2	25·0	11·8	18·7
900	11·5	17·2	22·1	25·3	26·4	34·0	26·1	29·9	1·2	2·0	3·1	5·8	9·2	21·9	9·1	17·0
1,000	8·0	12·2	17·1	19·1	20·1	28·0	20·7	23·1	0·8	1·4	2·2	5·0	8·0	18·2	7·2	14·4
1,100	5·3	10·2	13·2	14·3	15·2	23·1	16·5	17·9	0·2	1·0	2·1	4·2	7·1	15·3	6·0	12·3
1,200	3·9	8·0	9·8	11·0	11·8	18·3	12·6	14·2	—	0·4	2·0	4·0	6·2	13·2	5·1	10·3
1,300	2·3	6·0	7·2	8·0	9·0	14·8	9·7	10·8	—	0·3	1·9	3·9	6·0	11·3	4·3	9·1
1,400	1·4	4·2	5·2	6·1	7·1	11·3	7·2	8·5	—	0·2	1·7	3·1	5·2	10·0	4·1	8·1
1,500	0·9	2·4	3·8	4·8	5·2	9·3	5·6	7·1	—	0·1	1·6	2·4	4·4	8·2	4·0	7·2
1,600	0·3	1·8	2·3	3·0	3·9	5·9	3·5	4·6	—	—	1·5	2·2	4·0	7·1	3·2	6·0
1,700	0·1	1·0	1·8	2·2	3·1	5·0	2·9	3·5	—	—	1·4	2·0	3·8	6·0	3·0	5·1
1,800	0·0	0·0	1·0	2·0	2·5	2.9	1·6	3·3	—	—	1·0	1·8	3·0	5·2	2·2	4·0

From Table XVII., we see that the percentage of hits on the line formations are not proportional to the widths of the objects. Thus at 1,000 mètres, the company which has four times the front of a section, receives 15·2 per cent. of bullets while the section receives 13·2 per cent. This is easily explained. It depends on the relative widths of the object and the beaten zone. So long as the width of the object is greater than that of the beaten zone, the percentage on all objects of the same nature will be nearly the same.

The company column presenting eight men in depth appears to suffer only but little more than the column of half-companies presenting only four men in depth. The reason is that the latter column has double the width of the former one. The half-company column has only half the depth and width of the company column.

The columns by a flank are the least vulnerable; then come line formations, and lastly column formations.

Experimental firing has been carried out by all nations against *attack formations*, but the data obtained from such firing are of little value as the enemy does not remain in the open, but gets under cover, and he can alter the distance between the different lines if necessary.

The French regulations* say, "a collective fire may be opened :—

"At 550 yards, on a line of skirmishers of slight density (one man to every 5 yards).

"At 660 yards, on a line of skirmishers of average density (two men to every 5 yards).

"At 880 yards, on a thick line of skirmishers or on a company with open files.

"At the following *known distances*, fire if well regulated and directed, will produce satisfactory effects on troops in close order :—

"At 880 yards, on the closed group with a front of 5 yards.

"At 1,100 yards, on a line with a front of 11 yards.

"At 1,300 yards, on a line with a front of 22 yards, or a division of artillery, *i.e.*, 2 guns with their waggons.

"At 1,650 yards, on company columns of 200 men (at least), and on compact bodies of artillery, or cavalry.

"These limits, which are not absolute, can be increased when atmospheric circumstances are favourable, and when

* These have been almost exactly copied in the "Musketry Fire Tactics" laid down in our drill-book.

the means for correcting the fire exist. On the other hand they are too great when the means of correcting the fire is uncertain, or if the enemy is partly covered by obstacles."

The author regrets to say that he is unable to give any results from the few records that he has of the collective firing that has been carried out either in England or India. These trials have been carried out in a manner unsuitable for basing any conclusions on them, either on account of the few rounds fired or because of the too limited diagrams of the hits that have been made.

Statistics of the same nature as those already considered in this chapter are much wanted for the English rifle, for the results of certain experimental trials seem to show that they are not the same as those for foreign rifles.

Many deductions can be drawn from the data given in the foregoing pages, with reference to the best formations for infantry in battle during the various stages of the fight, but as such matters do not come within the province of this work, they must be left to the reader to work out for himself.

CHAPTER XI.*

INFLUENCE OF GROUND AND OBSTACLES ON THE EFFECTS OF INFANTRY FIRE.—INCLINED FIRE.—INDIRECT FIRE.—NIGHT FIRING.

Influence of Ground.

All that has been hitherto said, as regards the effects of musketry fire, refers to fire falling on ground, which, at the point where the bullets fall, is parallel to the line of sight, whether this latter be horizontal or inclined. But in reality the effect of the fire with regard to the dangerous and beaten zones, and the effects of ricochets vary very considerably with the nature, shape, and peculiarities of the ground on which the bullets fall. It is very important to study these different effects, as well as the circumstances which increase or lessen them, because it is only by such information that a rational use of the fire can be made, and that such tactical dispositions can be chosen as will offer the least chance of being destroyed by the fire of the enemy.

Before proceeding further, it is as well to make some preliminary statements to prevent confusion and to insure simplicity. In the following pages by "*rising ground*," and "*falling ground*," we shall mean ground at the point where the bullets fall, rising or falling, in the direction of the fire with respect to the line of sight, and we shall suppose it, unless otherwise stated, to extend for such a distance as to influence the whole dangerous zone. It may be remarked here that such rising ground is always visible, while the falling ground is invisible, to the firers. Thus in Fig. 14, in the direction of the fire, C E and D C are really rising ground, but they are falling ground in respect to the lines of sight A C G and B D H respectively. Similarly D C is rising ground both naturally and also to the line of sight A D F directed an object at D.

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* A great portion of this chapter is taken from the French *Règlement sur l'instruction du Tir.*

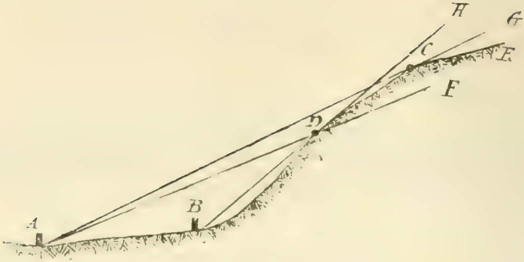

FIG. 14.

The *apparent crest* of such rising or falling ground, is the point where the line of sight forms a tangent to the ground, and hence from Fig. 14 we see that the position of this crest depends on the position of the origin of the fire; as the position of the origin of the fire alters, then there is a different apparent crest for each position. Thus, C is the apparent crest for an observer at A, and D is the apparent crest for an observer at B.

A fire is more or less *grazing*, with reference to a given slope of ground, according as the bullets pass over a longer or shorter extent of ground under the height of the objective above it, thus rendering dangerous a more or less considerable space.

The *dangerous zone* for an object of given height and for a given trajectory is, as we know, the extent of ground over which the given object can be struck by the given trajectory, and therefore the maximum dangerous zone is attained when the height of the trajectory above the ground, at any point along the range, does not exceed that of the object fired at, in which case the length of the dangerous zone will extend from the muzzle of the rifle to the point of impact of the bullet on the ground, and beyond this point also if the ricochet is considered.

The elements on which the extent of the dangerous zone at any given range depends are (1) the flatness of the trajectory for the range, (2) the height of the object, and (3) the shape of the ground on which the object is standing. The flatter the trajectory, the less the range, the greater the height of the object and the more parallel the ground is to the angle of fall of the bullet, the greater is the dangerous zone, and *vice versâ*.

We must now consider the influence of the shape of the ground on the dangerous zones. Suppose the ground, at the point of fall of the bullets, instead of being parallel to the line of sight, as we have hitherto supposed it to be, is inclined to this line.

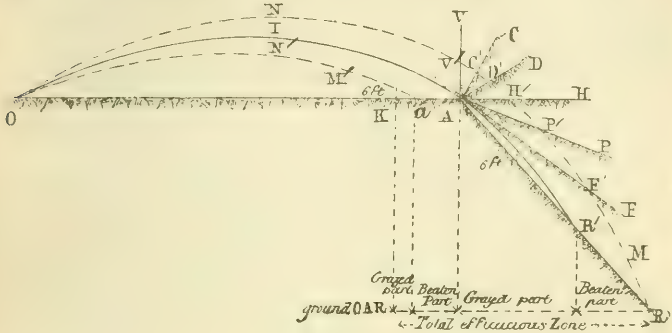

Fig. 15.

It is easy to see from Fig. 15 that when the bullets fall on rising ground the length of the dangerous zone decreases according to the steepness of the ground. But if the bullets strike on falling ground the dangerous zone is increased and is at a maximum when the slope of the ground, beyond the crest A, is just the height of the objective from the trajectory. Thus the increase of the dangerous zone, caused by different slopes of ground, is not indefinite, because as soon as the ground falls more than stated above, it is no longer grazed by the trajectory along its whole length. The total dangerous ground includes the ground grazed as well as the ground struck by the bullets. The depth of ground grazed is nothing else than the dangerous zone caused by the lowest trajectory. It is on this condition of grazing the surface of the ground, under the height of the objective, that the length of the dangerous zone depends.

From Fig. 15, we see that at the short ranges, for which the trajectories are very flat, the ground which gives the greatest dangerous zones is that which falls only slightly behind the object fired at. At the long ranges, on the contrary, where the curvature of the trajectory is much more accentuated, ground falling more and more rapidly, as the range increases, will be more favourable.

Thus a slope falling 1 in 50 with regard to the line of sight, behind the object fired at, causes a dangerous zone at 500 yards, three or four times greater than that on ground parallel to the line of sight, but at distances from 1,100 to 1,600 yards this inclination only produces an insignificant increase. At 1,600 yards it requires a slope falling 1 in 12, behind the object fired at, as regards the line of sight, to double the extent of the dangerous zones.

Let us consider a cone of trajectories (obtained by a collective fire) starting from the point O (Fig. 15), the line of sight O H being directed on a point A, in rear of which the ground presents different inclinations.

Suppose the central trajectory OIA to coincide with A, then if the nucleus of the cone is limited by the trajectories O N M O N′ M′; the surface struck on a vertical object A V is represented by A V′. But according as the ground slopes and has the different positions A C, A D, A H, A P, etc., the depth of the *beaten zones* becomes greater and has successively the different values A C′, A D′, A H′, A P′, etc. Finally, it reaches its maximum extent A F′ on the surface A F, which forms a tangent at A to the trajectory O I A passing through A.

Beyond this inclination begins a grazing fire down to the slope A R, which, for effectiveness against standing men, should never be more than 5½ feet below the trajectory passing through A. Thus from the point A, there will be a portion of ground which will not be beaten with the bullets but which will be dangerous throughout its whole extent to standing men so long as the lowest trajectory is not more than 5½ feet from the ground.

The under part of the nucleus falls on the ground between O and A, in advance of the point A, and causes a distance *a* A to be struck by bullets, and a distance K *a* to be grazed.

These differences in the depth of the dangerous and beaten zones practically remain the same whatever may be the position of Fig. 15 in space, caused by moving it around the origin of fire, O, as a centre; hence, according as the line of sight is inclined or horizontal, the extent of the shot groupings varies only according to the angle which this line forms with the ground which receives the bullets.

If we examine the grouping of the cone of bullets on planes parallel to, and at different inclinations to the line of sight, we see that this grouping is denser on ground rising with respect to the line of sight, and is less dense on ground falling with respect to it.

In some French experiments it was found that in a concentrated fire at 1,100 yards, the central nucleus, containing half the shots, covered a depth of 110 yards on ground parallel to the line of sight, viz., from 1,045 to 1,155 yards.

If we consider the intersection of these two extreme trajectories on ground of different slopes, the following results are obtained, where the fractions representing the slope express the inclination of the ground with respect to the line of sight, which latter cuts the trajectory at a mean distance of 1,100 yards from the muzzle.

For ground rising with respect to the line of sight:—

Slope.	Ground beaten with elevation for 1,100 yards.
$\frac{1}{50}$	90 yards—from 1,056 to 1,146 yards.
$\frac{1}{20}$	71 yards—from 1,065 to 1,136 yards.
$\frac{1}{10}$	55 yards—from 1,072 to 1,127 yards.

For ground falling with respect to the line of sight:—

Slope.	Ground beaten with elevation for 1,100 yards.	
$\frac{1}{50}$	136 or 68 yards	According as the whole or only half the nucleus falls on the sloping ground.
$\frac{1}{20}$	202 or 106 yards	
$\frac{1}{10}$	401 or 272 yards	

For less slopes than $\frac{1}{50}$, rising or falling, the depth of the ground beaten tends to approach 110 yards—the extent of the nucleus on ground parallel to the line of sight. *But on such slopes of small inclination, the beaten zones caused by fire at short distances have greater variations in depth than the beaten zones of fire at long ranges on greater slopes.*

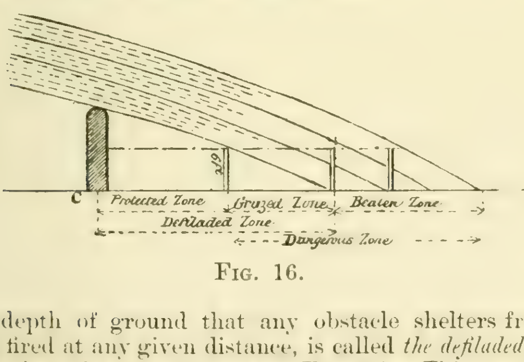

Fig. 16.

The depth of ground that any obstacle shelters from the bullets fired at any given distance, is called *the defiladed zone of the obstacle at the given distance* (see Fig. 16). This zone is the space which extends from the crest of the obstacle to the point

of impact, on the ground, of the trajectory which grazes the crest or top of the obstacle. If the obstacle is higher than a man, the latter can only be hit towards the end of the defiladed zone furthest from the obstacle, when the bullet passing over the crest comes within his height from the ground, *i.e.*, when it grazes the surface. Thus the grazed part only of the defiladed zone is dangerous, and consequently the *protected zone* is less than the defiladed zone by the extent of the grazed zone. The higher the obstacle, the greater are the defiladed and protected zones for a given range and given form of ground on which the obstacle stands.

When the height of the obstacle is less than that of a man, the protection it affords is only partial. Whether complete or partial, the protection afforded by obstacles, on any ground struck by bullets, has the effect of considerably diminishing the efficacy of the fire.

The defiladed and protected zones increase or decrease under the same conditions as those which cause the extent of the whole dangerous zones to vary. Thus they diminish as the range increases, and they increase as the height of the obstacle increases.

As the ground rises or falls with respect to the line of sight, the defiladed and protected zones are respectively decreased or increased for a given range and given height of the obstacle.

Although the extent of ground beaten or rendered dangerous varies according to its inclination to the line of sight, yet the trajectories of the bullets can in no way be influenced by the ground itself, and hence a vertical object, situated in the group of falling bullets, will always be equally liable to be struck, whatever may be the inclination of the ground on which it stands to the line of sight. Thus the results of a fire on a thin object without depth, such as a line formation for example, are not modified by the inclination of the ground. This line formation presents at all distances and on whatever ground it may be, an objective of an almost invariable height.

But this is not the case for echeloned or deep formations. Taking first the case of echeloned formations, a second line, in order not to be under the same fire as the troops in front, ought to be so placed in rear as to be out of its dangerous zone; thus its distance should be regulated by the inclination of the ground on which the bullets fall, and by the range, which latter affects the flatness of the trajectory and the angle of fall of the bullet.

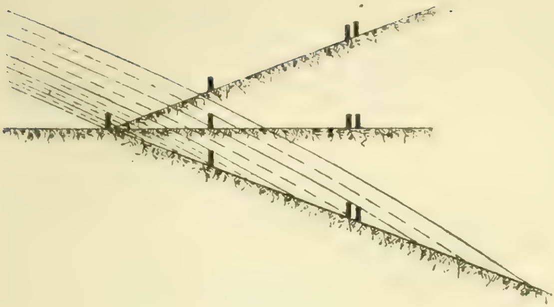

Fig. 17.

A battalion in attack formation (see Fig. 17) will not, therefore, have the same relative security in all kinds of ground. If the whole of this formation occupies 600 yards in depth, all the echelons may, in a favourable case, be comprised in the same dangerous zone on ground falling with reference to the line of sight, whilst on rising ground the rear echelons will not be struck by the fire directed on the first line. Hence it may sometimes be advantageous to deploy a force on ground sloping towards the enemy, especially if it has a steep slope, rather than on the reverse slope, if this latter be very gentle: that is, troops may often be safer on the exposed surface of a hill than on the reverse side of it.

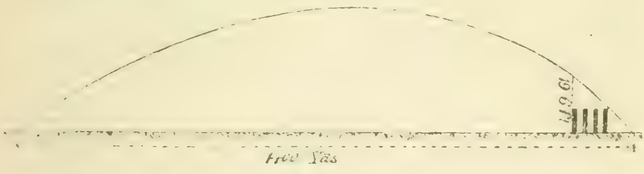

Fig. 18.

With regard to deep and closed formations, such as an English company column of 80 men in fours,* they are, as regards vulnerability, equivalent to vertical objects of greater height as the range increases (see Fig. 18). Such a column at 800

* The company is taken as having opened out one-third of its length, *i.e.*, it occupies about 36 yards in column of route.

yards is represented by a vertical object 12 feet in height, and at 1,400 yards by an object 19·6 feet in height on ground parallel to the line of sight. It thus has a considerable vulnerability, the amount of which will vary also with the inclination of the ground; and in Fig. 14 we see that this formation will

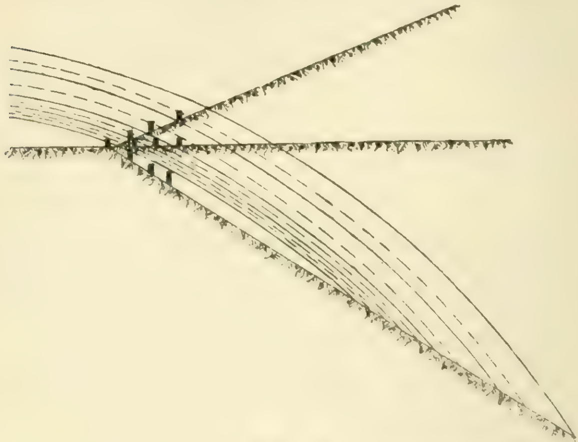

Fig. 19.

experience less losses on a slope falling with regard to the line of sight than on ground parallel to, or rising with regard to, the line of sight.

This effect is most felt on ground which falls sufficiently to allow the trajectory, which grazes the crest, to leave a defiladed zone behind it.

On ground rising with reference to the line of sight, the same formation on the other hand comes under very different conditions, for it is then struck by bullets which would have passed over them on ground parallel to the line of sight.

Thus we see that on a ground which rises as regards the line of sight, the fire is less grazing, while the grouping of the hits is denser, the objects are naturally more visible, and the observation—and therefore the correction of the fire—easier than with ground parallel to the line of sight.

On ground falling with regard to the line of sight the grazed zone is increased, but it is impossible to observe the strike of the bullets to regulate the fire by, and hence this

effect of the fire depends almost entirely on chance as we are trying to hit invisible objects.

It is, however, important to know the grazing effects of fire on ground falling with respect to the line of sight, so as to obtain as much of it as possible; but, if it is intended to make use of this kind of fire, we must expect to sacrifice accuracy of fire in trying to produce these grazing effects on supposed or unseen objectives.

Collective infantry fire is either plunging (*i.e.* dropping) or grazing, though it is impossible to say at what range the former begins. The longer the range, the more dropping is the fire; and the shorter the range, the more it grazes. The efficacy of a concentrated infantry fire principally depends on its grazing power over the whole depth of the dangerous zone.

From the want of efficacy of a dropping fire, it ought to be used with moderation, to avoid waste of ammunition.

A grazing fire may be a very efficacious one, when it covers a great extent of ground, but the amount of ground covered depends on the range, on the elevation, and on the form of the ground at the point where the bullets fall.

A little consideration will show that the higher the ground on which the objective stands above the origin of fire, the greater should be the range, to produce the same efficacious fire from grazing. Thus, to obtain an efficacious fire, we must have a good idea of the reliefs and slopes of the ground; but, according to some French writers, the given efficacious effect is to be got not only at the exact range corresponding to these conditions, but also for some 50 yards under and over it.

To obtain the same effect on different slopes, at the same height above the origin of fire, the men firing must go further from the crest, according as the inclination, with respect to the line of sight, of the slope in rear of it, gets greater.

The fire becomes eccentric when it is delivered from a point nearer than the proper distance corresponding to each slope and difference of level, that is, a defiladed zone is created in rear of the crest fired at.

We see that firing at troops on ground falling with regard to the line of sight, comes under the heads of dropping and indirect fire, and, knowing the angle of fall of the bullets for different ranges (Table I., on p. 8), the slope of the ground, and the position of the troops, an effective fire might be kept up by placing the troops firing at a range suitable to the fall of the ground.

In the field, the exact slopes of the ground in front cannot be—or very rarely can be—ascertained, and it will be rarely possible, even if known, to place troops in the exact positions from whence the slopes can be effectively swept; hence such a mathematical use of infantry fire cannot be accurately made in the field; but, in sieges and investments, when the slopes of the ground of the defence will be probably known, such fire can be largely used. In action, infantry fires directly on what it sees, and has enough to do to regulate this direct fire to get decided results, without trying for doubtful results by any such indirect or dropping fire, which would further entail a great expenditure of ammunition.

However, since the shape of the ground has more or less influence on the effect of the fire, this influence should be thoroughly understood by all officers, so as to draw the greatest possible advantage from it. Slight folds may hide from view, but not from fire, and thus, if the range is known, firing may be continued with success, even though the enemy has disappeared for the moment.

According to the nature and degree of the slopes near the object aimed at, the depth of the zones swept or grazed by the projectiles may be diminished or increased, and thus it may be necessary to modify the normal rules for the use of sights. In ground rising with respect to the line of sight, the dangerous zones are diminished, and hence a greater number of sights are required than on ground parallel to the line of sight, to cover the same extent of ground by the fire (see Italian regulations, p. 142). Similarly, on ground falling with respect to the line of sight, the dangerous zones are increased, and a less number of sights may be required.

Another point with reference to the use of fire on hilly ground, is the permissibility of firing over the heads of troops in front. From the flatness of the trajectories of rifles, this cannot, as a rule, be permitted in the field on ground parallel to the line of sight, but it may be used in sieges, when the rifles are fired from rests, or when firing indirectly over an obstacle of such a height as to render it impossible to strike the troops in front. The danger is not so much from the low height of the trajectory of the bullet above the line of sight, as from the careless or bad firing of the troops. As far as the trajectory is concerned, the bullets would always pass over the heads of men in front, if the right elevation was used, and the line of sight also directed over the heads of the troops in front *i.e.*, if the objective can be seen over them.

As a preponderance of fire is the deciding element n battle, with modern long range weapons, troops must get accustomed to the sound of fire passing over their heads, though, if possible, they should be warned of it beforehand.

The French regulations say with reference to the influence of the form of the ground on the results of the fire :—

" In a fight, troops cannot choose their own ground.

" In the offensive, as in the defensive, the tactical units operate on the place assigned to them: they cannot leave the field of action told off to them without hindering the advance, or paralyzing the fire of the adjacent fractions. They ought, therefore, to utilise the ground given them in the best manner possible.

" The remarks which follow are intended to shew the advantages and disadvantages which different shapes of ground offer as regards the effect of fire.

" With modern tactics, based on the disposition of the troops in depth, and on the carrying out of the combat by a firing line of extended troops, the knowledge of the accuracy of the arm at different distances does not give a complete idea of the value of fire in war.

" Other things being equal, two adversaries on horizontal ground possess the same power of fire, but not so on hilly ground where fires of equal accuracy cover very different zones, according to the configuration of the soil.

" The depth of the dangerous ground is increased by ground falling with respect to the line of sight; it is diminished, on the contrary, on rising ground. These augmentations and diminutions are so much the more accentuated as the inclination of the ground with respect to the line of sight is greater.

" Ground falling with respect to the line of sight presents a crest which hides objects in rear from the view of the enemy.

" If the fire is directed on this crest with the exact elevation of sight for the range, half the bullets fall in front of the crest, *the other half pass above it, and fall further from the crest as the range is shorter, as the angle formed by the ground with the line of sight is greater, and as the bullets themselves pass at a greater height above the crest.*

" There results from this not only an increase in the depth of the surface struck, but also the creation, in rear of the crest, of a zone of ground more or less deep, above which the bullets pass at a greater or less height. This zone of ground

is said to be grazed by the bullets; but it only does so in an efficacious manner if the lower trajectories are not more than half the height of a man above the ground."*

With regard to *fire directed on ground rising with respect to the line of sight*, the French regulations say:—

"The objectives are visible and perfectly distinct from one another; they are only indifferently sheltered or masked by the folds of the ground, and an efficacious fire can be directed on each of them.

"Objects without depth have the same vulnerability as on ground parallel to the line of sight. Close column formations† of any kind are the most vulnerable, but the depth of the dangerous ground is much diminished.

"The supports and reserves will not generally suffer from the fire directed on the firing line, and can therefore only be hit by a fire directly aimed on them.

"The effects of ricochets are less dangerous than on ground parallel to the line of sight or falling with respect to it (see p. 205).

"On ground rising with respect to the line of sight, in order to obtain the same depths of beaten ground as those obtained with one sight on ground parallel to the line of sight, it is necessary to employ two or three sights."

With regard to *fire directed on ground falling in respect to the line of sight* the French regulations say:—

"*When executed under favourable conditions*, these fires have the advantage of rendering dangerous great spaces in rear of the crests. The bullets directed on the defenders of the crest can hit the supports and reserves at distances at which these echelons could only be touched on ground parallel to the line of sight by a fire being directly aimed on them with the proper elevation of sight for the distance.

"A fire directed on ground falling with respect to the line of sight, renders the position of artillery difficult when it is established at the crest.

"But it must not be forgotten that the objectives in rear of the crest are invisible to the adversary and that consequently it will only be due to chance if they are hit by a fire concentrated on a narrow front.

"Generally they can only suffer from the fire directed on

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* Because troops in rear of the crest would be resting on the ground.

† Such as a quarter-column and a column of route in fours.

the front line, and these objectives are so much the less vulnerable as their front is more restricted, their formation more compact, and their positions better chosen.

"The ground grazed is less dangerous than the actual zone beaten by the dense part of the cone of bullets.

"*To get the best result possible the fire on even very gentle slopes requires to be delivered from relatively great distances;* at shorter ranges it becomes less efficacious as the enemy's position is approached. Besides, it is impossible for the assailant to appreciate the inclination of any ground falling with respect to the line of sight, as he cannot see it.

"With such ground, a fire executed at the medium ranges, (see p. 266) on a position known to be strongly occupied by the enemy, may furnish excellent results, should it have a simultaneous effect on the firing line and on the fractions of troops in rear.

"Efficacious fire can commence at greater distances than those alreadylaid down (see p. 182) for ground parallel to the line of sight.

"From the above it results that collective fires, of small width, are not the best for the attack of a position of this kind; it is only an individual fire, spread uniformly along the enemy's front, that can sweep all the ground in rear of the crest and strike the troops in reserve.

"It is advantageous to advance rapidly up to the probable distance *(which is very difficult to appreciate exactly)* at which the fire furnishes the maximum depth of dangerous ground on the opposite slope."

Commandant Paquié, of the French army, has published some *brochures* on this question of inclined fire, and has given much interesting information concerning it, some of which we will now give.

In firing on inclined ground, if the inclination of the ground on which the bullets strike is equal to the angle of fall of the lowest trajectory, that just passes over the crest, the beaten zone is $2\frac{1}{4}$ times that on ground parallel to the line of sight, and if the slope of the ground is equal to the angle of fall of the mean trajectory the beaten zone is $2\frac{1}{2}$ times greater. If the ground is so inclined that the lowest trajectory, after passing over the crest, rises $5\frac{1}{2}$ feet above the ground, the dangerous zone, from the crest to the point of impact of the highest trajectory, is 5 times the beaten zone on ground parallel to the line of sight, but for this last condition to be fulfilled the slope of the ground behind the

crest, with reference to the line of sight, must be $\frac{4}{100}$ if one fires at 440 yards, $\frac{5}{100}$ if one fires at 550 yards, and so on. On other slopes for the above ranges, and the farther the distance of the origin of fire is from the crest, the less is the depth of the efficacious zones. Thus on ground inclined $\frac{5}{100}$ to the line of sight a fire at 990 yards range only produces an efficacious zone of twice that on ground parallel to the line of sight; at 770 yards 3 times greater; and at 550 yards 5 times greater, as already stated.

From calculations made of the grazing effects of fire of the rifles at present in use, the following rule has been deduced, that, in order to graze a horizontal plateau, whose height is H feet above the origin of fire, it is necessary that this latter should be at a distance in yards of $60 \cdot 3 \sqrt{H}$. Thus the origin of fire should be at more than 420 yards for a difference of at least 50 feet, and more than 750 yards for a difference of at least 150 feet, and so on.

The calculations from which these data are derived show that the flatter the trajectory of the rifle the further must the origin of fire be in order to efficaciously cover a horizontal plateau with fire. What is gained in flatness is lost in efficacy of inclined fire.

To obtain the same beaten or efficacious zone, when the slope of the plateau rises or falls beyond the crest, the distance of the origin of fire must be respectively diminished or increased 100 yards for every unit of rise or fall in 100 units horizontally.

From what has been said, we see that an inclined fire may have two effects, one on the crest at which it is directed, and the other at some point on the ground beyond it.

To complete this subject of *Inclined Fire*, we must give the German method of treating it, even at the expense of some repetition. In doing so we have now to consider the modifications which have to be applied to the normal series given in Table A, when the bullets fall on a surface more or less inclined (rising and falling with respect to the line of sight.

The basis of all the calculations on this subject depends on the principal of the *rigidity of the cones of dispersion*. This principle may be stated as follows: We may, for practical purposes, consider the cone of dispersion of the bullets of a collective fire as a rigid cone. This cone is so permanently connected with the movements of the line of sight that it rises and falls with the latter, provided the elevation or depression remains within certain limits.

The principle of the rigidity of the trajectory is not an

absolute one. It is only true within certain limits for relatively small angles of elevation or depression of the line of sight, such as are usually employed on a battlefield. The principle of the rigidity of the cone of dispersion has, however, larger limits than when applied to a single trajectory, on account of the larger surfaces covered.

The study of the modifications to be made to the normal series, when the cone of shots falls on a surface whose inclination differs from that of the line of sight, is perhaps the most interesting of all those subjects which relate to collective fire, because from the examination of these modifications arise the simple and practical rules on which the Germans base their field firing. The normal series only apply to a flat surface parallel to the line of sight, and as combats in war rarely occur on such ground, it happens that, as a general rule, the bullets fall on surfaces rising or falling with respect to the line of sight. In these cases the real angle of fall differs from the normal angle of fall, and consequently the theoretical dangerous zones are increased or diminished, the beaten zones lengthened or shortened, and the density of the hits increased or diminished. But these modifications cause corresponding variations in the effective dangerous zones, and modify the value of the real destructive effects of the fire, and hence their study is essential, if we wish to direct rationally the fire of infantry on varied ground.

The normal series on a surface parallel to the line of sight are averages obtained between the effects produced on surfaces rising and falling with respect to the line of sight. The modifications given by theory have been tested by experiments on varied ground, and found to be correct.

Two methods can be employed in the theoretical study of these variations of the normal series.

The first method consists in finding the alteration in the number of hits on screens placed 10 mètres apart; and the second method consists in finding the distance apart of screens, to obtain the same number of hits on them as in the normal series. As this latter method is much the simplest it will be adopted here.

It is easy to show that the theoretical dangerous zones, the beaten surfaces, and the distances between the screens, on ground sloping with reference to the line of sight, in order to obtain the same number of hits on each of them, are inversely proportional to the tangents of the angles of fall. Hence, in order to get the same number of hits on each, the

distance between the screens on ground sloping with reference to the line of sight should be equal to—

$$10.\ \frac{\text{Tangent of real angle of fall.}}{\text{Tangent of normal angle of fall.}}$$

Also we have—

$$\frac{\text{The normal depth of ground beaten.}}{\text{The real depth of ground beaten.}} = \frac{\text{Tangent real angle of fall.}}{\text{Tangent normal angle of fall.}}$$

The normal angle of fall of a bullet is the angle of drop with reference to the line of sight. *The real angle of fall* of a bullet is the angle of drop with reference to the inclination of the surface of the ground that it falls on.

For *ground rising* with respect to the line of sight, the real angle of fall is equal to the normal angle of fall increased by the angle formed between the line of sight and the surface of reception.*

For *ground falling* with respect to the line of sight, the real angle of fall is equal to the normal angle of fall diminished by the angle formed between the line of sight and the surface of reception.† If this last angle is equal to the normal angle of fall, the bullets graze the surface of the ground; and if it is greater than the normal angle of fall, then the bullets do not graze the surface of the ground, but pass above it.

In the study of these questions, we must avoid the danger of accepting the results in a too dogmatic spirit, and of not sufficiently considering their tactical aspect, which is by far the most important thing in war. Thus, from purely theoretical deductions, one might be tempted to introduce into the execution of fire on the battlefield exact and complicated methods of procedure, involving, in critical situations, the use of tables of ordinates, slopes, corrections for barometer and thermometer, differences of level, etc., as well as the knowledge of certain data, which, as a rule, it is not possible to obtain, viz., the slopes of the ground on which the enemy is standing. This error has been avoided by the Germans, who, as we shall see, have collated some precepts for the direction of fire on varied ground as simple as their rules for fire. Hence, though we are not able in the field to obtain with certainty the data for giving the fire its *maximum effect*, yet we can be certain of obtaining for it *satisfactory results*, with the aid of simple rules which can be carried out by all officers, even in the midst of a hot action and only requiring a knowledge of the

* To find this angle, suppose it to be denoted by a, and the slope of the ground by s, and the inclination of the line of sight by i; then, if these angles are considered positive when they are angles of elevation in the direction of the fire, and negative when angles of depression, we have $a=s-i$.

† Using same notation as in last footnote, $a=i-s$.

elevation and of the range to within one-eighth of its real distance, and also a slight notion of the direction of the inclination of the surface of reception with regard to the line of sight. The actual value of this inclination can never be known, even from the maps usually carried by officers, as they are on too small a scale to show it; but officers who have been practised in field firing on varied ground soon find out by experience the relative effects of the slopes of the ground on the destructive effects of the bullets. What they must remember is that on *ground rising* with respect to the line of sight the real angle of fall is greater than the normal angle of fall, and on *ground falling* with respect to the line of sight the real angle of fall is less than the normal angle of fall.

On account of this, on *ground rising* with respect to the line of sight, the theoretical dangerous zones and beaten zones are *diminished*; and on *ground falling* with respect to the line of sight they are *increased*; their respective lengths in respect to the normal lengths being inversely proportional to the tangents of the normal and the real angles of fall.

The *density of the hits*, on the other hand, *i.e.*, the hits per yard or mètre of depth, varies directly as these tangents, so that it *increases* with *ground rising* with respect to the line of sight, and *decreases* with *ground falling* with respect to the same line. The shorter the beaten ground the denser the hits of the shot-grouping. But as the destructive effect of a cone of dispersion is measured by the density of the hits per yard (or mètre) multiplied by the length of the theoretical dangerous zone in yards (or in mètres), it results that the product is constant. Consequently the reduction of the dangerous zone is compensated for by an increase of density, and *vice versâ*.

This conclusion, however, only applies to a fixed objective and a well regulated fire. But we must not lose sight of the fact, that accidental effects can often be produced in other troops than those on whom the fire is specially directed. In the field, distances are never exactly known, and can rarely be exactly regulated, and the objectives never remain fixed for long, but are advancing and retiring. Hence, on *ground rising* with respect to the line of sight, which diminishes the dangerous zones, it will be more difficult to make the bullets fall on the objective, than on *ground parallel to, or falling* with respect to, the line of sight. Hence, the practical destructive effect, that is the sum of the conscious and unconscious, or of the direct and indirect effects of a fire directed on an object, in war, is always smaller when this object is placed on ground

rising with respect to the line of sight, than when it is placed on ground parallel to this line. The opposite is the case when the fire is directed on ground falling with respect to the line of sight.

Consequently to ensure the bullets of a collective fire covering an object placed on ground rising with respect to the line of sight, we will have to make use of two or three combined elevations at distances where one, or, at the most, only two elevations would have been used if the ground was parallel to the line of sight. On the other hand, when the object is placed on ground falling with respect to the line of sight, often only one elevation need be used at distances where two or three elevations would have to be used if the ground was parallel to the line of sight. But we must not lose sight of the fact, that, in this case of firing at an object standing on ground falling with respect to the line of sight, we neither know its distance nor its exact position, and, further, it is impossible to observe the results of the fire. Such a fire is called an *indirect fire* (*see p.* 231), because we are obliged to aim at some other point than the object to be hit.

When the ground is falling with respect to the line of sight, then, if the angle which the ground makes with the line of sight is equal to the normal angle of fall for the range, the bullets which pass over the crest, graze the surface of the ground for some considerable distance, and their real destructive effect is very great. But if the angle formed by the ground and the line of sight is greater than the normal angle of fall, then the bullets passing over the crest rise above the ground behind it (at an angle equal to that formed by this surface with the line of sight, diminished by the normal angle of fall), and strike the ground at a considerable distance behind the crest. There are then, in this case, two groupings separated by a zone which may be wholly or partially grazed by a portion of the whole cone. The results of such a fire are very variable, and are most often bad. Consequently when such ground occurs, this disadvantage must be fully weighed before having recourse to indirect fire, for we can never know the slopes of unseen ground, and they may be such as to give a very bad effect to our fire, which would therefore become wasted.

The following table for the Mauser rifle gives the reductions to be made in the 10 mètre intervals of the normal series in order that each screen may have the same number of hits on it, when the ground rises with respect to the line of sight; it also gives the total lengths of the efficacious dangerous zones on the same ground.

TABLE XVIII.

Elevation for	Normal angle of fall.	Number of rounds fired.	Depth of efficacious dangerous ground. When the ground is parallel to the line of sight.*	When the ground makes an angle with the line of sight of +3°	+5°	+10°	Reduction of the 10 mètre intervals in the normal series when the ground makes an angle with the line of sight of +3°	+5°	+10°
m.	° ′		m.						
400	1·10	100	210	63·00	42·00	23·10	3·0	2·0	1·1
500	1·40	100	200	75·50	50·40	29·40	3·5	2·4	1·4
600	2·10	100	170	68·00	51·00	28·90	4.0	3·0	1·7
700	2·50	100	130	62·40	43·50	27·30	4·8	3·5	2·1
800	3·30	100	110	55·00	45·10	27.50	5.0	4·1	2·5
900	4·20	200	140	81·20	64·40	40·60	5·8	4·6	2·9
1000	5·10	200	110	69·30	56·10	39·60	6·3	5·1	3·6
1100	6·0	200	120	79·20	64·80	44·40	6·6	5·4	3·7
1200	7·0	200	80	55·20	45·60	32·00	6·9	5·7	4·0
1300	8·10	300	100	72·00	61·00	43·00	7·2	6·1	4·3
1400	9·20	300	110	82·50	70·40	50·00	7·5	6·4	4·6
1500	10·30	—	—	—	—	—	7·8	6·5	4·9
1600	11·50	—	—	—	—	—	8·0	7·3	5·2
Total			480	761·30	594·30	386·40			
Mean			134	70·00	54·00	35·00			

From this table we see that the average depth of the efficacious dangerous zones is 134 mètres for the Mauser rifle in the normal case, and it is 70, 54, and 35 mètres when the ground rises 3°, 5°, and 10° respectively with regard to the line of sight. Or in other words *the efficacious dangerous zones are approximately equal to $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{4}$ of the normal efficacious dangerous zone when the ground rises respectively* 3°, 5°, *and* 10°

*See footnote on page 160.

with regard to the line of sight, and consequently are approximately equal to 2, 3, *and* 4 *times the normal efficacious dangerous zone when the ground falls* 3°, 5°, *and* 10° *respectively with regard to the line of sight.*

Hence every time the ground of reception rises about 3° with the line of sight it is necessary to employ two elevations; if it rises about 5°, three elevations, &c. Thus, though we cannot be sure of making the bullets fall on the objective with a single elevation, yet with two or three elevations we can not only ensure this, but are certain to obtain an efficacious fire.

On the other hand, when the efficacious dangerous zones are increased by the ground falling with respect to the line of sight, we can cover a great depth of ground with an efficacious fire by means of a single elevation.

The practice of combining sights has therefore the effect of not only counterbalancing the effect of movement of the objective, of errors in judging the distances, and of deviations caused by atmospheric influences, but also of the alterations in the lengths of the effective dangerous zones caused by variations in the slope of the ground of reception with respect to the line of sight. All these causes of error, when working together, often have a very considerable effect. Further, the practice of combining two or more elevations does not entail a useless consumption of ammunition. Often superior results are obtained by the use of two combined elevations to those obtained with a single elevation with the same consumption of ammunition. (See pp. 163 and 164).

On undulating ground, the bullets fall on ascending and decending slopes connected by almost horizontal plateaux. Consequently the real dangerous zones differ but little from the normal ones when the slopes of the ground do not exceed the value of the normal angles of fall for the trajectories of the longest ranges of the rifle. When the origin of fire has a small command over the surrounding ground, the real dangerous zone may even sometimes be greater than the normal ones.

In firing uphill we obtain, as a rule, longer effective dangerous zones than firing downhill. But this does not prove that firing uphill has a greater absolute value than firing downhill. In the first place in firing downhill we are often able to obtain the tactical advantage of two tiers of fire; further, we can more easily see the enemy's movements and regulate the fire, by watching its effects, and thus profit by the losses inflicted on the enemy to hasten on the success of the action.

But when there is a choice of position, infantry ought to avoid a too elevated site, unless for temporary purposes, or unless they are compelled to occupy it by the circumstances of the fight. The best position is a crest which does not dominate the surrounding ground too much. But this rule is by no means absolute, for infantry have often to cover the artillery which must occupy the crest; in this case they must move down the slope and often partially up the opponent's slope, in order to keep the enemy's skirmishers at a distance of at least 1,200 yards from the artillery.

Effect of the Form and Nature of the Ground on Ricochets.

The length of each of the ricochets is increased by a ground falling, and decreased by ground rising, in the direction of the bullets' movement.

Generally ricochets go to a greater distance as the angle of drop of the bullet with regard to the surface of the ground is smaller.

When the ground is of average hardness, this angle should not be greater than 15° in order that the bullets may ricochet.

Soft ground, or ground covered with thick vegetation, or with a surface cut up by transverse projections or furrows, stops the greater number of the ricochets. A soil hardened by frost or firmly-set sand is, on the contrary, eminently fitted to make bullets ricochet.

Stony ground makes the ricochets very variable, and causes splinters of stone to fly about.

If the profile of the ground on which the bullets fall short, has a slightly concave or hollow form, as in Fig. 20, these bullets will ricochet on to the object. But if the profile of the ground is convex, as in Fig. 21, they are likely to pass over the object. A rounded crest therefore, in front of the object gives a good protection against ricochets.

Fig. 20.

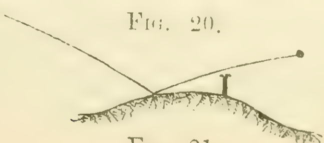

Fig. 21.

The appearance of dust thrown up by the bullets in ricocheting, facilitates the observation and correction of the fire.

In firing down hill, as in Fig. 22, or into the face of a hill, as in Fig. 23, there may be no ricochets.

Fig. 22.

Fig. 23.

On the Occupation of Ground Inclined to the Line of Sight.

When firing from a low position to a higher one, as from a valley at an enemy on a ridge, a wide or more than one dangerous zone is obtained, and the result of the fire *may be* very great under favourable circumstances. In the cases shown in Figs. 24 and 25 we see two zones of ground swept by fire, one at the crest and the other beyond it, which latter *may* possibly inflict injury on the enemy's supports or reserves, especially if the ground on the reverse slope to the origin of fire is more or less parallel to the trajectory or remains within $5\frac{1}{2}$ feet of it. On the other hand, in considering the defender's fire from the crest (see Fig. 22), the dangerous zone will be greatly diminished by the plunging nature of the fire, which will also diminish the effects produced by ricochets, and there will be, besides, only one dangerous zone swept by the fire; hence, theoretically, the position of the defender on the crest of the hill will be worse than that of the attack.

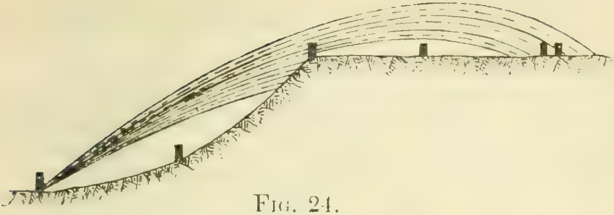

FIG. 24.

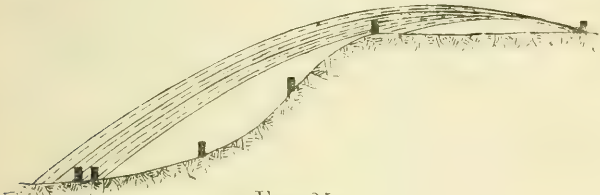

FIG. 25.

Now, suppose the line of defence to be retired on the plateau, 500 to 800 yards from the crest (see Fig. 25), then the situation is reversed, because when the defenders fire on the enemy's firing line, as soon as this latter reaches the crest, the bullets which graze this crest *may* sweep the slopes behind it, *if they have a suitable inclination*, and strike the troops in rear.

These considerations, and others to be referred to presently, have caused many military writers, especially among the French,* to dispute the advantage of taking up a position at the crest of rising ground.

A defensive position can be taken up in one of three different manners :—

1. The crest of the position may be strongly held.
2. From the powerful concentration of fire, to which the crest is subjected, the latter may be lightly held, and abandoned at an opportune moment, and the battle fought out at a second and main line of defence, 500 to 800 yards in rear of it.

* Commandant E. Paquié is perhaps the most able advocate of the views to be now exposed. His two best-known works are :— *Tir incliné de l'infanterie* and *Feux de guerre*. The Author regrets that as the latter book was not procurable, (being out of print,) he has not been able to make use of it.

3. A line in front of the crest may be held by infantry, leaving the crest for the artillery, and as a cover for the reserves.

But the value of ground, for a defensive position, must not be examined merely as regards its effect on the efficacy of fire and the cover that it affords, but we must also consider how it facilitates or delays the movement of troops, how the flanks are secured, and other such tactical points.

As it is essential to arrive at the truth in the vital question of the method of defending a position, we will first deal with the arguments of those who oppose the hitherto accepted method of holding the crest of a position as the main line of the defence and then give the criticisms of their opponents.*

We will, before doing this, state what the probable manner of occupation of a crest line would be.

The defence aims at two points:—(1). Resistance with which to destroy the enemy's power of assault and his power of resisting counter-attacks; and (2). The offensive return, or counter attack, which alone can gain success. Hence the object of the defence is to keep the enemy under fire in circumstances unfavourable to himself. To do this, the defenders try to draw advantage both from the ground itself and from their own fire. Formerly these advantages were sought for by selecting a position with passive obstacles in front, which could only be crossed by the enemy's columns at certain points under effective fire. But this obstacle equally prevented any decisive offensive return. With the modern breech-loading rifle—with which a man's fire may be considered as continuous—it has been found by experience that the best obstacle to offer to an attack is a clear and wide field of fire, and hence the modern idea of a good position is one which offers an extensive and clear field of fire in front of a series of strong tactical points of support,† *within supporting distance*

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* It is here fair to warn the reader that, although the Author considers a strong occupation of the crest line, or of a line in front of this crest line, as the general rule to be followed, and the strong occupation of a line in rear of the crest as being only suited to special cases, yet he has made every endeavour in his power to give a fair representation of both sides of the question.

† "The defence ought always to try and augment the value of the ground by fortification, and the shelter trench has become for it a condition of life or death."—(Von Scheff.) Again, although the following words were written with regard to a line of detached forts, they apply equally well to a line of strong points:—"A single fort is of little use, but a front of forts, where the enemy cannot pass one without coming in reach of the adjacent fort, has a different aspect."—(Von Waldstalten.)

of one another, which are strongly occupied, while fewer troops are placed in the intervals. The artillery and the reserves for the counter-attacks are posted in, or in rear of the intervals. The strong points draw the enemy towards them, exposing his flanks to the intervals, from which local offensive returns can be made. The efficacy of such returns depends on their being made at the proper moment, with all the energy possible, and on the flanks of the enemy in preference. Offensive returns, through the weakly held intervals, can be made at any period of the fight, to take advantage of any mistake of the enemy, or to gain time by forcing the enemy to temporarily halt, but these earlier offensive movements should only partake of the nature of local sorties, which retire again, as soon as their object is attained, under the protection of the strong points; they should not have a decisive character, which should only belong to the counter-attack made about the period of the assault, when the enemy is in the greatest confusion. Second, and, in some cases, third lines of defence should be prepared to check any local advantage gained by the attack in the front line, to prevent it spreading right and left, and to force the enemy to retire, by the powerful fire directed on him from the lines in rear. Thus the offensive-defensive being looked to as the best method of defence, the defence reserves all the troops it can for offensive returns by telling off, to man the front line, the least number of troops that may be considered sufficient to break the strength of the enemy while maintaining their position. To do this it concentrates its forces at the strong points, so as to obtain at them the most powerful fire possible to the front and flanks, and holds the intervals less strongly. Fire is only opened when the enemy arrives at the most favourable distance for the efficacious action of the defender's fire.*

The French official publication, *Quelques indications pour le combat*, thus describes the arrangements made by the defensive in the defence of a position:—

"The defensive draws its principal strength from its fire, and from a judicious employment of the ground. The perfecting of fire-arms has been especially profitable to the defensive, by rendering possible the destruction of the assailant at a long distance.

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* This varies with the size and height of the objective, and with the accuracy with which the ranges are known. See Chapter X

"In the defensive, it is important to deceive the enemy as long as possible as to the exact position chosen; as to the troops which are concentrated there; as to the development of the line of defence, and as to the points on which its flanks rest.*

"The infantry of the line of battle, posted according to the ground and the probable direction of the attack, will hold itself in readiness in rear of the positions assigned to it.†

"If there are in advance of the principal line of defence, at a distance of 850 to 1,300 yards, any obstacles (such as farms, woods, &c.) having a good view in the direction of the probable attack, they must be included in the line of battle, by occupying them by battalions or companies, according to their importance.

"These woods, farms, &c., are the bastions of the line of battle; they are flanked by it.

"The mission of the troops which occupy them, is to break the first efforts of the enemy, by defending, *to the last man*, the positions which have been confided to them.

"As a rule, there is no advantage in disseminating the infantry by making them occupy more advanced posts. The defenders of such posts, being out of reach of support, would be easily driven in by the advance guard of the assailant, and their movement to the rear would produce a fatal impression on the *moral* of the troops.

"It is specially with *the fire of the whole* that the defence ought to act.‡ Consequently, the dissemination of the infantry ought to be avoided."

The attack, at the opening of an action, concentrates its artillery fire first on the artillery and then on the strong tactical points of the defence; this fire is supplemented, when considered advisable, by the fire of strong lines of infantry; and as soon as the demoralization of the defenders is secured and his artillery silenced, the attacking lines are then pushed forward to the assault.

Arguments against the occupation of the crest line of a position.

The opponents to the occupation of the crest-line of an elevated position base their arguments on the effects of

* This is a very good reason for the use of advanced posts.

† The object of this is to gain the moral effect of *an advance* into position.

‡ That is to say, the defence ought not to rely only, for any particular or important object, on the fire of particular points.

inclined fire that we have already mentioned. They say that the exposed position of the defenders and of their strong tactical points, allows of an overwhelming fire, from both artillery and infantry, being easily directed on them, which will soon break down their strength and the cover they give, and demoralise the troops holding them, and that, while doing so, the bullets which pass over the crest-sweep the ground in rear with a rain of projectiles,* which will cause such great losses among the supports and reserves, as will prevent these reinforcing the firing line or carrying out their counter-attacks. Thus, the fire of the attack menaces all the defenders' lines and their ammunition columns, ambulances, &c., in rear, while the fire of the defence only menaces the one object actually fired on (see Fig. 22). The strong points of the defence, which usually consist of houses, walls, farms, villages, &c., placed in a state of defence, cannot stand against artillery fire. The occupation of the crest merely hides the troops in rear from the view of the enemy, but not from his fire. A fire inclined upwards is more efficacious than one inclined downwards; also men firing downhill always fire higher than men firing uphill. The enemy's artillery, after silencing that of the defence, can still keep up its fire, on a defended crest-line, out of range of the infantry fire of the defenders.

A French writer makes the following remarks with regard to inclined fire, firing uphill at the crest of a plateau :— "If a fire is opened at such a range, which varies with the elevation of the ground, that it only gives a dropping fire, the crest will be so much the better beaten as the nucleus of the bullets falls more on it, but the slopes in rear will be very little swept. But when the extreme distance is reached, at which a grazing fire begins to be obtained, the crest will be better beaten, and the fire will soon begin to graze the slopes for nearly 200 yards, to which must be added the effects of ricochets, increasing the danger to the supporting troops in rear of the firing line.

"As the distances are approached at which the fire produces the greatest grazing effect, the bullets passing over the crest will graze the ground to nearly 600 yards in rear, rendering the reinforcing of the firing line or its retirement a dangerous

* In action all men usually fire high, and hence nearly all the bullets would pass over the crest. This is especially the case at the closer ranges, when the men will not lower their sights.

matter, and forcing the supports and reserves to keep themselves well under cover *if they are in the line of fire.*"*

At first sight these arguments seem very strong in favour of the opponents to occupying the crest of a position, who say that instead of this, the position should be so occupied that the main line of defence should be placed some 500 to 800 yards (*i.e.*, within effective musketry fire) in rear of the crest, if the plateau is open and affords a good clear field of fire. The position taken up in rear of the crest would, as before, consist of a series of strong points within supporting distance of one another. The crest is not to be obstinately defended, but only held as an advanced line, to reconnoitre and watch the enemy and, to compel him to deploy early† in order to show his hand and delay his advance, and to fight him and cause losses among his troops until he approaches the crest, when its defenders retire, so as to leave him exposed to the effective musketry fire of the main line of defence, under which the artillery of the attack cannot come into action without being destroyed, and the attacking infantry cannot further advance. The artillery of the defence would be still further in rear, beyond the effective musketry range of the attack, now in possession of the crest, and would aid the infantry fire of the main line of defence, by firing over it, while it cannot be silenced in this position. Under these conditions, walls, houses, farms, &c., can be fully made use of by the defence, as they cannot be destroyed by distant artillery fire, and after demoralizing the attackers by a combined artillery and infantry fire, the decisive offensive return can be effectively made. Thus the artillery of the attack cannot now gain that preponderance of fire, by which alone the action of its infantry can be prepared and can succeed. The main line of the defenders and their supports and reserves are not reached by the bullets which graze the crest, while a position in rear of the crest reverses the conditions of the inclined fire, and now

* The italics are our own.

† "It is inconvenient for the attack to deploy at a great distance from the enemy; this is a reason why the defence should try and compel it to do so." (Von Schreff). This is one great reason for making use of advanced posts. The advisability of making use of advanced posts is not confined merely to the conditions that they should be within supporting distance of the crest and have an assured line of retreat. Their greatest advantage lies in their forcing the early deployment of the enemy, and thus to bring early into his ranks, confusion and disintegration.

gives the defenders the chance of reaching the enemy's echelons in rear of his firing line by the bullets, which pass over the crest, of the fire directed on it (see Fig. 25). The true object of a fight is not merely to gain ground, but to attain the destruction of the enemy; the required ground is gained after this. Otherwise, to apply the principle of men not yielding ground, the line taken up by outposts or by an advanced guard ought logically to be made the line of resistance. Hence the retirement of the troops from the crest cannot be objected to, while this feigned retreat will probably draw on an enemy, deceived by an apparent success, to certain destruction. The advanced troops would be taken from the reserve, which they would rejoin after retiring, so as to leave the main line of defence intact and undemoralised by any losses.

The advocates for always taking up a position in rear of a crest, support their conclusions from examples drawn from the fighting that took place *during the investments* of Metz and Paris by the Germans in the war of 1870-71. During these phases of the war some examples are to be found of defending a position in rear of the crest which were attended in all cases with success.

The German positions at Champigny and Buzenval in front of Paris well illustrate the method of defence described above.

At the battle of Champigny the French made a sortie against the German investment lines. The lines of defence at this point were about 400 yards in rear of a crest of rising ground which commanded it slightly, as the ground sloped gently down from the crest. The German infantry were posted behind crenaleted walls, and their artillery behind epaulments. This line was completely hidden from the view of the French artillery. The French infantry found no difficulty in dislodging the enemy's detachments from their advanced positions in front of the crest. At the crest itself the resistance was firmer, still not serious; the Germans retired, seeking to entice the French after them. These, on arriving at the crest, were subjected to a heavy fire, but they succeeded in obtaining some shelter, and returned the fire without doing the Germans, who were well sheltered, any serious damage, and awaited the arrival of their guns, which were required to effect a breach in the enemy's position, so as to enable them to assault it. As soon, however, as the guns showed themselves, and before they could even be got into action, a withering short range rifle fire was directed on them, inflicting such heavy losses, that

all but a few guns were prevented from opening fire, and even these were speedily silenced, and the artillery was compelled to retire. The infantry, which had also been stopped, was not able to resume its advance, and had, therefore, also to retire. General Ducrôt, narrating these events, says, "We have been vanquished by the ground."

At the battle of Buzenval the same thing happened. The French ascended the slopes of the plateau held by the Germans in rear of its crest; the French reached the crest, but found it impossible to bring a single gun into action. The French infantry found itself singly opposed to the two combined arms, infantry and artillery, of the enemy, covered by walls and epaulments, and could not, consequently, do anything.

Some writers have pointed out that the above principle of the occupation of ground is not by any means a new one, as it was the custom of the Duke of Wellington, whenever he wished to take up a defensive position, to seek out a plateau, and establish himself behind the crest, *just out of view of the enemy*. The front slope was defended by skirmishers, who retired before the advancing French *columns* of attack, which, on arrival at the crest, were overwhelmed, thrown into the most complete disorder, and demoralised, by a heavy fire of bullets and of case from guns, from the real line of defence, about 50 yards in rear of the crest, followed up by a bayonet charge in line, which invariably was successful.

On similar principles to those already given, the opponents to the defence of the crest of a position deny that the front edge of a wood, of no great depth, is the best line for defending it. They consider that the wood should take the place of a crest-line in what concerns the combined action of artillery and infantry; the true line of defence, they say, is situated within musketry range in rear of the wood, from whence it will be invulnerable behind the cover it would utilise, necessitating the intervention of artillery in order to be forced. The edge, they consider, constitutes an excellent advanced line, but that an obstinate resistance should not be made at it, because the maximum effort cannot be produced there, as the assailant presumably possesses a superiority of artillery and infantry fire. Infantry placed at the edge of a wood can effectually oppose an enemy's infantry, but when the action of the latter is assisted by artillery, the defenders, who cannot be effectively backed up by their own artillery, are very badly situated. As an example of this, at Spicheren the French held the crest of

a steep slope covered with woods, but they did not strongly hold the lower edge of the woods. The Germans soon found their way through the woods to the crest, but could not advance beyond that point, even after the guns had been dragged up, until the French left flank was turned and they had retired.

Arguments in favor of holding the crest line of a position.

The advocates for defending the crest-line of a position say that, although the *theoretical* exactness of the statements already given for inclined fire cannot be contested, yet we must guard ourselves in practice against drawing too absolute conclusions from them.

In dealing with the defence of localities, they say that the modern method of placing houses, farms, villages, &c., in a state of defence, is not to hold the walls and houses themselves at first, but to choose a natural or artificial line in advance of them, composed of hedges, enclosures, ditches, raised roads, abatis, shelter trenches, &c., against which obstacles artillery has but little effect. The walls and houses would only be occupied *after* the outer line had been penetrated by the enemy and the enemy's artillery compelled to cease fire for fear of hitting their own troops.* In proceeding in this manner we can, without fear, choose as strong tactical points in the line of defence, the villages, &c., found situated on the crest. Strong points, so situated, have also the great advantage of giving an extensive view over the ground in front, and are thus able to assist in the defence of the position in a manner which they could not have done if they had been situated far in rear of the crest.†

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* The following description of the occupation of St. Privat is given by an anonymous French author (C. C. J.), who is in favor of defending a position in rear of the crest. "A brigade defended the village, but did not occupy it; it was posted round the edge, like an exterior ring, 300 mètres in front of it; the walls were crenaleted, and shelter trenches constructed; the village itself was the objective of the Prussian artillery; the advanced line did not suffer at all." The French only evacuated this position for want of ammunition, and because their right flank was turned, in spite of the nearly 200 guns that were eventually brought to bear on the village. The line chosen for defence should be far enough in front of the houses to prevent splinters and falling masonry hurting the men. Another great advantage in this advanced line of defence is, that it is possible to maintain a better control over the men than if they were scattered in different houses or parts of a house.

† "Avoid choosing villages to be fortified from which the surrounding ground cannot be well seen, or which are dominated within rifle range." —(General Brialmont).

The wood at Spicheren, if it had been strongly held, along its front, would not have been penetrated by the Germans, who in turn could not have taken the Rotherberg spur in flank. As the French held the crest of the Spicheren plateau, the loss of the wood caused an opening in the line which had a bad effect on the French troops in forcing them to retire, and only made them more ready to retreat altogether, and not utilize their large unemployed reserves when they imagined their left flank had been turned.

With reference to the fighting round Metz and Paris in 1870-71, of which we have quoted two cases, those of Champigny and Buzenval, General Brialmont writes—"Those who quote the battles around Paris and Metz in order to prove that the Germans established their principal line of defence in rear of the crest, forget the difference between the defence of a line of investment and the defence of a position by an army in the field. In the former case, points of resistance (parks, private country residences, farms, &c.), situated in rear of the crest, are occupied in preference, so as to be, as much as possible, sheltered from the artillery fire of the besieged; in the latter case, on the contrary, the points of resistance are chosen so as to menace the flanks of the troops who try to pass them, and they are consequently to be found either in advance of the first line of battle or on this line. An entrenched village, situated in rear of the crest, would be, doubtless, less exposed; but it would also produce less effect. We ought not to lose sight of the fact that artillery has resources and can employ methods of procedure which give to its indirect fire an efficacy, which the indirect fire of infantry cannot obtain. The problem consists less in selecting villages, &c., to serve as strong tactical points in a line of battle, in such situations as are sheltered from the fire of the enemy's artillery than in organizing their defence so that this fire can produce but little effect," in the manner already stated. The French sorties from Metz and Paris were directed against a continuous investment line, so that they had no flanks to attack, while their own were exposed; and it must not be forgotten that the German positions were so chosen and fortified as merely to gain time to concentrate their troops, in superior numbers, before attacking and driving back the French. Again and again we read how the French sorties were stopped and driven back, not so much by the frontal fire they met with from these retired positions that the Germans took up, as from the physical obstacles they

met with, and the flank counter-attacks that were directed on them.

In the numerous cases in the Franco-German war, where a position was occupied at the crest there is no indication to show that the effect of the fire passing over the crest was in any way approaching to what has been stated, or that it prevented a vigorous defence from being carried out, or supports and reserves from coming up. The French positions were almost invariably captured by being out-flanked and turned, and not by the effect of the fire directed on the crest line of the position.*

With regard to the Duke of Wellington's method of procedure, it can be stated that the properties of inclined fire were not known in his days, and that all he aimed at was to act by surprise. He placed his troops *in line* on the top of the ridge or plateau, just far enough in rear of the crest as to be out of sight of the enemy. The French attacked *in columns*, who, when they arrived at the crest, saw suddenly before them our deployed lines, who at once poured one or two volleys into the dense masses before them, and then, before the French could recover the effect, they dashed forward with the bayonet, and drove back the helpless and disorganized French columns. No one can assert that the same success would have been obtained against deployed or extended troops, and hence, our successes were due more to the vicious attack formation of the French, and to an intelligent and rational employment of fire by the English, than to the fact that the principal line of resistance was in rear of the crest.

Coming now to the more technical considerations of inclined fire, allowing that the assailants' fire does pass over the crest, the troops and artillery on the crest, and the echelons in the rear, can always protect themselves by masks of earth or other shelters. *In dealing with the question of inclined fire, we have seen how much a knowledge of the ranges, of the differences of level, and of the slopes of the ground with regard to the line of sight, enter into the question, none of which data are, or can be accurately*

* At Gravelotte, the French occupied the crest of the position, and the second French Corps (Frossard) numbering 19,000 infantry, placed in sheltered trenches on the left of the French position, was attacked by two German Army Corps (70,000 men) ; and while these latter suffered enormously, its loss in killed was only sixty men and officers, in wounded 366, and in missing (due to wounded and unwounded prisoners) 195: total 621. These numbers included four killed, twenty wounded, and one missing from among the reserve (or corps) artillery, and three missing from among the Administrative Services. All the remaining losses were among the infantry.

*known in the field.** The effect of an inclined fire from an advantageous range, depends on a large number of rounds being fired from the same position, but attacking infantry, in order that the offensive spirit may be properly kept up, will never remain long at any one spot, and as they only fire very few rounds at each range, such a really dangerous zone is never formed as would stop any reinforcement by the supports and reserves, who can always take the opportunity of moving up during the pauses in an enemy's fire, or over those parts of the ground which are not receiving his collective fire. Besides this, many of the bullets will be stopped by the obstacles and hillocks which exist on every ground in civilized countries.

A near approach to the crest tends to create on the reverse slopes of a plateau a protected zone, which increases in depth and height as the range decreases, allowing of masses of troops to be concentrated near the crest, or the firing line to be retired, without danger.

Thus, as the enemy approaches the crest, the defiladed zone in rear of it gets greater and greater, and the bullets passing over the crest, fall further and further in rear of the position, allowing reinforcements to approach in safety, just at a time when it is required for them to do so. This is easily seen from Fig. 26.

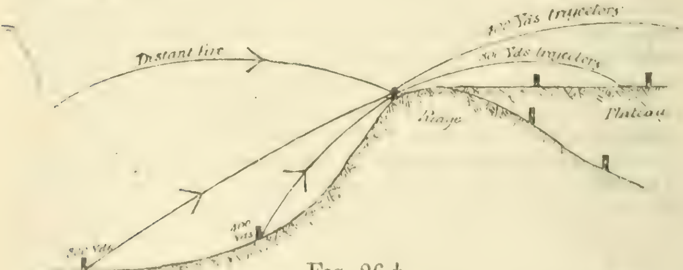

Fig. 26.†

* Commandant Paquié disputes the necessity of knowing these data accurately. "The appreciation of the difference of level and of the distances do not require great accuracy; for a difference of level of 25 to 35 mètres, the fire at any range between 600 and 500 mètres, is very efficacious; for a difference of level of 15 to 25 mètres, a fire at any range between 500 and 400 mètres, acquires a maximum of power. The difficulty of estimation is not great, as we see, and an inclined fire leaves a very wide margin in this respect, on account of its efficacy; its execution is, therefore, essentially practical. . . ."

† For the sake of clearness, the cones of fire are shown by their mean trajectories only.

The whole theory of inclined fire depends on the men knowing their ranges, the differences of level between the origin of fire and the crest of the position, and altering their sights. The two former they may, in some very favourable cases, know exactly, but the latter they will not do under 400 yards from the crest, and so the bullets under that range go well over the crest and far away to the rear. This will also tend to happen at all ranges at which the attackers are being fired on, the moral effect of which will be to enormously reduce the theoretical efficacy of inclined fire, even under the most favourable circumstances for it.

Coming now to a position in rear of the crest-line, as soon as the troops at the crest are withdrawn, the enemy can mass his troops at any point he likes, unseen. If the assailant finds himself confronted by a position in rear of the crest, and that he cannot advance beyond it, he can easily find shelter behind the crest from the defenders' fire, and can entrench himself and throw up epaulments for his guns. The artillery of the attack could even fire indirectly over the crest, having the effect of its fire watched and signalled back. At all events, as modern battles are tending to increase in length, and modern infantry will carry entrenching tools, the night could be taken advantage of to move troops round the defender's flanks, and to throw up the necessary earthworks to continue the fight on more equal terms next day.* As the attack presupposes a superiority, even night attacks could be attempted from so short a range with every chance of success. The defender's view being limited, he cannot see the enemy's movements, where he is massing his troops, or if his flanks are being turned, which will immobilise troops on both flanks, where they would have to be kept until the attack was far developed.

We have pointed out that a good position must allow of counter-attacks being made. If the attack cannot advance beyond the crest, neither can the defence attempt an offensive return from the close, unshaken fire of the attack. Examples of this were again and again seen in the fighting round Paris. Counter-attacks are best directed against the flanks of the attack. A position in rear of a crest lightly held would make

* General Skobeleff, after two failures in direct assaults by day on the forts of Plevna, with enormous losses, finally gained his object by a slower and more methodical process. He took up successive positions at nightfall, and fortified them sufficiently during the night to be able to successfully hold them by day.

the enemy deploy equally strongly along his front, having no strong points to draw his troops towards, and hence the enemy would not offer any flanks to be attacked by sorties.

The advocates of holding the crest-line, or edge of a locality, insist on the importance of holding the outer line of defence as the main line, which should, therefore, have an extensive and clear field of fire, and of only looking on any other positions in rear of this as secondary to the outer line, because once this outer line is captured or pierced, the defence loses the important advantage of long range fire over known ranges, and thus in respect to infantry fire, the defenders are then no longer superior to the attackers, who, on the other hand, are superior in numbers, and can, therefore, bring a greater amount of fire to bear on the defence.

The moral effect of the troops retiring from the crest-line must be seriously considered. It cannot be considered as similar to the retreat of outposts. All generals of renown are unanimously agreed that moral elements have a preponderating importance over material causes. Napoleon I. said, "In war everything is moral force"; and again, "In war the moral force is to physical force, as three to one." The troops in the main line in rear of the crest, would hear the fighting and see nothing for some time, and may even receive many stray shots to which they cannot reply; their minds get in a state of anxious tension from the imagination being worse than the reality, and when all of a sudden they see the troops who were on the crest come running back, it cannot but have the most demoralising effect. *

If the crest is occupied, the defenders will take care to cover themselves with natural cover or entrenchments, and so will only expose little of their persons; the echelons in rear will be similarly sheltered; the assailants are fully exposed during their advance, and their movements and dispositions can be seen; the artillery and the rifle can be utilized to their fullest ranges; the enemy cannot see the echelons in rear, while any of the enemy's echelons can be fired on; the effect of the fire can be seen and watched, and allowed for if it is ill-adjusted; the time for opportune counter-attacks can be well judged; the artillery of the attack must cease firing when their infantry arrives near the crest, and as the fire of this infantry passes well in the air beyond the crest, the supports and reserves can

* On p. 210, we saw that a French official publication states that troops in advanced posts are not to retire, but to fight to the last man.

easily come up in safety; if the artillery of the defence is overpowered, it can retire temporarily and re-open when the attacking artillery has to stop firing;* and a commanding position adds to the moral force of the troops holding it, by giving them a feeling of security, and takes away from that of the attack, which has only an imperfectly defined crest-line to fire at, and one which changes with the range. (See Fig. 14.)

General Brialmont writes:—"Infantry can only fire well at objects that they can see, and hence we would only deceive ourselves very much if we placed it 660 to 770 yards in rear of a crest, and expected it to sweep this crest with its fire and hit the assailant (whom they cannot see), whilst he advances up the front slope of the plateau. In fact, it is very rare that a crest-line can be sufficiently clearly made out to be used, by the enemy, as a point to aim at. In most cases, it is invisible, on account of the brushwood, clumps of trees, hedges, crops, &c., which cover the ground, and hence the fire, directed on it, cannot have any precision."

With reference to the statement, that if the firing line is at the crest, the ground on which the supports and reserves have to advance is dangerously swept, General Brialmont writes: —"This argument has not the importance that is attached to it; first, because, in order to sweep the plateau on which the echelons of the defence are placed, it is necessary to take up a certain fixed position, and on either side of this the trajectories cease to graze the ground; secondly, because in the defence, the number of echelons can be reduced, or brought nearer to one another, and sheltered in trenches; thirdly, because the reserves and main body ought only to advance at the moment when the fight takes place on the crest, when, consequently, the fire of the attack has ceased to sweep the plateau."

A line of defence is not now-a-days uniformly occupied, and hence there will be intervals which, having no fire, will not attract that of the enemy. It is behind these intervals that the troops in support would be placed, and thus they would not suffer from the fire which the occupied parts draw on themselves.

The efficacy of *tiers of fire* has been proved by experience.

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* The French artillery frequently did this in 1870-71. Perhaps in the near future artillery will be provided with bullet-proof shields to enable it to continue to fight under the fire of infantry and shrapnel.

and their effects are such as to justify, in almost every case, where the ammunition can be spared, a great consumption of ammunition. It is of great use to fire on the enemy's reserves when they can be seen, even at short ranges, to try and compel them to retreat, as they invariably draw back with them the lines in front.* It is only by holding a crest line that these tiers of fire can be obtained, and, as we have seen, the front slope of a crest may be less dangerous than the reverse one. The German regulations acknowledge this, and recommend that in suitable cases, a position on the front slope should be taken up. Another advantage of lines of fire from shelter trenches on the front of a slope, is, that the enemy's fire tends to keep the men in their places, for they feel that they run into danger by trying to retire. Tiers of fire are more usually obtainable than is commonly thought. Crest lines are rarely clearly defined, and, as troops should always see the foot of the slope to be defended, they must be placed a little way down it, at what is called the *military crest* (see D., Fig. 14), in contra-distinction to the *true crest* (see C., Fig. 14), and then a second line can be formed for more distant fire from the top. Thus, in Fig. 14, troops at C cannot see B, and so they ought to be placed at D, and then a second tier of fire can be obtained at C; also, if the defenders' firing line is at D, the enemy's fire is not so likely to go over the crest to sweep the ground in rear.

Commandant Paquié, says that—"The principles involved in the inclined fire of infantry counsel a slow advance, and an increase of the intensity of the fire at distances which procure the maximum of power. It is, therefore, of some use to know the distances which allow of dominant positions being swept over all their depth. . . . . The assailant who rapidly crosses the zone which gives his fire its maximum power (see footnote, p. 218), in order to expose himself sooner to the close fire of the enemy, and to produce a less effect, does not know how to make use of his weapon." All tacticians are now-a-days agreed that once infantry are launched to the attack, they should carry it out with all the energy possible;

* The value of firing on reserves was well illustrated in the third battle of Plevna, when General Skobeleff repelled the fourth counter-attack made on him by the Turks, after he had captured the redoubts, by firing, not on the Turkish firing line, but on their reserves in rear, whom he thus compelled to withdraw, and who were soon followed by their firing line. This shows that a cloud of skirmishers cannot protect or mask closed troops in rear of them when opposed to an able enemy.

but if they acted as above advocated, the offensive spirit, so essential to success, would soon be completely destroyed; besides, no one can carry in their heads the data for inclined fire, or be expected to carry tables for them, and to examine them under a hot fire in action.

Crest-lines for defence are always to be found, while suitable positions for defending it from a distance are rarely so; and hence, this latter method must always be the exception, and not the rule. And, if a considerable plateau does not exist behind the crest (see Fig. 26), as is often the case, and the position held is a ridge, the whole theory of the efficacy of inclined fire, based on its theoretically deep beaten or efficacious zones, falls to the ground. The experience of war sanctions the use of the crest-line, and no examples can be fairly given shewing the supposed terrible effects of inclined fire on reverse slopes.

Inclined fire depends for its effect on fairly long ranges; it is directed on a thin and sheltered firing line at the crest of a position *in the hope* of reaching the echelons in rear. But, as we shall see in Chapter XII., such long range fire ought invariably to be concentrated and directed on objects of suitable dimensions. But a fire concentrated on a narrow front does not give good results for inclined firing, as we have seen that the French regulations state (see p. 196); to obtain any efficacy with an inclined fire we must use individual firing, uniformly beating the whole crest, and hence, in using infantry fire as inclined fire, with the object of covering the ground in rear of the crest with bullets, we run a great chance of wasting valuable ammunition, which can only be replaced with the greatest difficulty. (See Chapter XIII.)

Finally, as rifles with far flatter trajectories than those at present in use are likely to be generally adopted at an early date, the supposed efficacy of inclined fire will be greatly reduced.

Positions in rear of a crest-line are doubtless suitable for special cases, such as a second line of defence in rear of the crest; for investment lines which are exposed to very powerful artillery fire from the forts, &c., of the defence, and in which the main object is to gain time to collect the besiegers' superior forces; or for the defence of any very steep positions which have to be taken up, the front slopes of which are unsuitable for being held. The unsuccessful defence of the Rotherberg spur, at the battle of Spicheren, and of Majuba Hill, in the Boer war, illustrate the danger of defending at the crest such very steep

slopes as allow of the enemy collecting unseen and in safety at the foot, or near the crest, for a further offensive movement; and this advantage the advocates for the defence of a position in rear of the crest, would always give to the attack.

Whatever may be the practical effects of inclined fire, we cannot help owning that very useful information is obtained in studying its possible effects, so that should these effects ever be realized, officers may know how to act. A knowledge of the possible effects of inclined fire will also prevent officers being surprised when they receive some bullets in a position where it appears their men ought to be sheltered.

The German regulations say on the subject of inclined fire: "If the fire is directed on ground inclined in one direction or the other, the length of the dangerous zone is shortened or lengthened according as the ground rises or falls and proportionately to the slope. There is an advantage when the ground on which the object stands is parallel to the line of sight, or is inclined slightly below it, and a disadvantage when it rises. It is just the opposite as regards the efficacy of the enemy's fire." This is all that can really be said about inclined fire, and these simple statements are far from offering a basis on which to build a new theory for the occupation of positions.

"It should be added that if the Germans practice field-firing on varied ground they do not attribute to inclined fire the same importance which some French military writers ascribe to it. The Germans modify the normal rules for the use of sights in accordance with the nature and degree of the slopes near the object aimed at, slopes which may diminish or increase the depth of the zones swept or grazed by the projectiles. They admit, also, that it may be sometimes advantageous to deploy a force on ground sloping towards the enemy, if it has a steep slope, rather than on a reverse slope which may be very gentle. They carefully avoid sacrificing to a formal idea the very diverse factors which occur in war, and guard against the fault of pushing technical speculations to their utmost consequences."—*Revue Militaire de l'Etranger.*

Arguments in favour of holding a line in front of the crest-line of a position.

Another method of occupying a position has been seriously proposed of late, which is to place the main infantry line of defence well down the front slope of a position. On p. 187 *et seq.*

we have seen that the steeper the slope of any ground rising with respect to the enemy's line of sight, the less is the beaten zone; on p. 190 we saw that a thin line is always equally liable to be struck, whatever may be the inclination of the ground, on which it stands, to the enemy's line of sight; on p. 191, we saw that deep echeloned dispositions are often safer on the front slope of a position than on the reverse slope; and from Fig. 14, p. 186 we see that a fire directed on the point D will not sweep the reverse slope, if D is sufficiently far down the front slope.

In placing troops in this manner, two or more lines of infantry fire from shelter trenches can be obtained, and artillery can be brought into action on the high ground in rear of the infantry while the fire directed by the enemy on one objective cannot strike those in rear; in fact to hit any one objective the fire of the enemy would have to be specially directed on it. If infantry are placed at the crest none of these advantages can be obtained. If the artillery of the defence are overpowered they can be retired out of sight until a more favourable occasion for its use occurs, or fire indirectly over the crest.

As the infantry firing lines would be well down the slope the enemy would have no reason to fire on the crest, and hence the reserves of the defence can be kept in safety close in rear of this covering mass, and from their elevated position they can well see when and where their action will be most opportune. The enemy, not knowing where the defenders' reserves are, is not likely to waste his ammunition by firing on all points of the crest in hopes of reaching them in rear of it.

In inclined firing the maximum results are obtained in the medium ranges and at the shorter of the long ranges (see p. 266). Hence the "position of resistance," that should be taken up in front of the crest, should be so far in advance of it (450 to 550 yards) as to prevent the assailant being able to reach the distances most favourable for him to fire on the crest and the ground in rear of it without coming under an effective short range fire of the defence. If the line chosen in advance of the crest is at the bottom of the valley, then the defenders will have the advantages which an uphill fire is considered to possess.

While the firing line by its resistance forces the enemy to deploy and to bring up his reserves, those of the defence can be moved in safety and unseen on the plateau and can be used, if necessary, to fire over the heads of the troops in front.

"From a tactical point of view, the defence of heights offer considerable advantages. From his dominating position the defender sees all the assailant's movements, the direction, number and formations of his attacks; he can force the enemy to show his intentions, and he can then make the necessary dispositions to meet them. When the ground in advance of the crest is cut up with obstacles or enclosed, the defenders, from their elevated position, can still see the enemy and fire on him, and while the assailant must shew his hand, the defence can, on the contrary, conceal its own. The defenders can hide the position that they may occupy, their lines of resistance, the number and formations of their troops, the march and direction of movement of their echelons and counter-attacks; and further, they fight on known ground. The necessity for the defence having to determine the ranges more accurately, on account of the diminution of the dangerous zones, is largely compensated for by the facility with which it can measure the distances beforehand; lastly its fire can be better observed, especially volleys.

"As to the artillery, dominating positions are advantageous for it, because, placed a little in rear of the crest, and being defiladed either by the folds of the ground, or by improvised epaulments, it escapes from the view and from much of the fire of the assailant; its fire will plunge down more on to the enemy, making it harder for him to find cover; it can observe and regulate its fire; and lastly, it can, like the infantry, measure beforehand the distances of the probable positions that will be occupied by the artillery of the attack.

"Finally, the fire of infantry against artillery will be executed in good conditions for the defence, if it takes up a position in advance of the crest, and in the valley, as its first line of resistance; it can thus find opportunities to stop the advance of the hostile artillery, or to make it suffer losses by a fire at 1,000 mètres. This would not be the case if this line were placed at the crest or in rear of it."

The French official publication, *Quelques indications pour le combat*, apparently recognises the above advantages, as can be seen in the extract already given from it on pp. 209 and 210.

One thing that must strike every one after a study of the foregoing pages, is the great importance which must be now-a-days attached to *the knowledge of ground and its employ-*

ment, in knowing its use offensively and defensively, and its effect on the fire, both in the attack and defence. The value of ground is not absolute; it not only varies with the nature of the arms, with their range and combinations, but it depends also on the actual positions that the troops occupy on it. "A knowledge of the ground is no less indispensable for the attack than the defence,—here to profit by some strong points, there to avoid them. The ground dictates to the defence the points of resistance and the tactical dispositions; it indicates to the attack the directions in which a bayonet attack has no chance of success, and those where it can succeed. . . . Tactical dispositions ought to be based on the properties of the ground; an ideal formation on a horizontal ground would be annihilated if it were blindly placed on intersected and varied ground; there does not exist any panacea applicable to all cases."

The French regulations say, with respect to the occupation of ground inclined to the line of sight, "The advantages and disadvantages of such ground, as regards its occupation, follow principally from what has already been said about the fire which troops occupying it are exposed to; they depend also on the efficacy of the fire that the troops can produce.

"*Ground Falling as regards the Enemy's Line of Sight.*

"The most favourable ground for defence is one which presents, in front of the firers, a clear glacis, forming a free field of fire of great extent, and inclining gently in the direction of the enemy.

"The greater the inclination of the slope in rear of the crest the better are the echelons in rear, situated on the reverse slopes of the position, sheltered from the fire of the attack. To cover steep slopes with fire it must be executed at the longest ranges, which takes from its accuracy, and reduces its efficacy.

"Slight undulations of ground hide troops from the view of the enemy, but they are not sheltered by them from fire coming over the crest in their direction.

"In the occupation of these positions the firing line should be sufficiently in advance, so as to overlook the ground, and to leave in rear a sufficient mask to protect the reserves.

"Every position which forces the defensive artillery to come very close to the firing line, although the enemy's batteries can fire from their normal position, is defective or badly occupied.

"The line of defence placed in front of the crest will not be

occupied uniformly along the whole front. There will be intervals which, having no fire, will not attract that of the enemy.

"It is behind these intervals that the troops in support will be placed. They will thus, in a great measure, be sheltered from the fire directed on the firing line, and close to the emplacements which they will generally have to occupy when it becomes necessary to reinforce their line of fire.

"If the ground in advance of the crest has a steep slope and offers natural shelter, stages of fire can be made use of, if the fire from the upper lines does not present any danger to the fractions in front, lower down the slope.

"The troops placed in rear of the line of defence ought not to think themselves out of reach of the enemy's fire because they are hidden from his view. If there is no shelter they ought to take formations with a narrow front, and remain at a distance when the enemy fires at long ranges, and according as the enemy advances, they must approach the crest to protect themselves from the effects of his fire, which, as the ranges decrease, falls farther in rear.

"This forward movement coincides, further, with the tactical neccessities of the fight.

"On ground falling as regards the enemy's line of sight, the observation of the points where his bullets fall furnish a useful indication as to the positions which should not be occupied by the supports and reserves, because these points depend on the form of the ground, and not on the wish of the firers.

"In the choice of a second line of defence, when it is not imposed by the nature of the ground, and the existence of natural obstacles, the distances to which it will be possible to efficaciously beat the slopes in advance of the crest, and up which the enemy must advance, should be considered.

"It is at these distances, determined on beforehand, that the shelter trenches or other works of this second line of defence must be constructed, which will so much the better permit of stopping the pursuit and of re-establishing the fight, as the enemy's artillery comes more within the efficacious zone of musketry fire, which will better prevent its coming into action.

"*Ground Rising as regards the Enemy's Line of Sight.*

"Ground of this nature is favourable to the carrying out of the fight by the firing line principally.

"On such ground, column formations of any kind are

eminently vulnerable, and hence line formations, with intervals between the subdivisions, are preferable.

"The distances between the different echelons may be less as the inclination of the ground is greater.

"The echelons in rear of the firing line will, as a rule, only suffer from the fire especially directed on them.

"They ought therefore to make use of every accident of the ground to cover themselves; if there are no artificial or natural shelters, they will find that, in order to join the firing line, their best protection is an uninterrupted forward movement, so as to rapidly cross over the diminished dangerous zones, which allows them also to get away, in a single forward movement, from the effects of any regulated fire of the enemy.

"Finally it should be pointed out that such ground has the grave disadvantage of exposing all the defensive dispositions to the enemy, who can see all the movements carried out in the interior of the position."

The Germans have made considerable experiments on inclined fire against the attack formations of their probable enemies, but the results of these experiments have been kept a profound secret, being only entrusted to senior officers.

Plunging, Curved, or Dropping Fire.

Obstacles forming a covering mass furnish a more or less considerable protection according to the height of the obstacle and the range. Therefore, to hit an enemy placed behind a shelter, the men firing must be placed at such a distance that the bullets rise high enough in their trajectories to fall with a high angle of drop, and so to diminish the depth of the defiladed zone, by plunging or dropping, so to say, behind the obstacle. This kind of fire is called a *curved*, *or plunging*, *or dropping fire*.

The efficacy of a dropping fire depends on the angle of drop of the bullets on striking. On looking at the trajectory table, pp. 8 and 9, we see that at 800 yards an object eight feet high covers on ground, parallel to the line of sight, a depth of $8 \times 18 = 144$ feet in rear of it and at 1,400 yards only $8 \times 8 = 64$ feet in rear of it, so that troops in line immediately in rear of such cover would always be safe from infantry fire and even if they did suffer they can evade it by moving to the right or left as the enemy cannot see them nor the effect of their fire. The greater the angle of drop, the greater is the *searching power* of the fire, as it is called.

Thus to ensure effective results from a dropping fire in the

field, the range, the direction of the object, and the nature of the ground in rear of it must be accurately known, and if the distance is not suitable, the range must be altered. But this can only be done when there is plenty of time at disposal, as in a siege, where the objects fired at are stationary, and thus very favourable for a dropping fire. But such a fire may even then be ineffectual if the defenders are well provided with traverses, blindages, &c., &c. Under ordinary circumstances, however, in an engagement in the open field, a dropping fire is of little practical use.

A dropping fire, as said above, can, under favourable circumstances, render great service in sieges; but it can only be employed with any degree of efficacy by placing the men at sufficiently great distances from the obstacle.

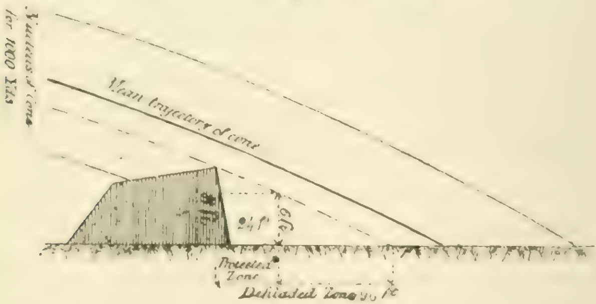

FIG. 27.

Siege and rampart batteries have, as a rule, an average height of about 8 feet above the fighting terreplein. At a distance of 1,000 yards, and for an obstacle 8 feet high, the defiladed zone has a depth of 96 feet, while the protected zone for a standing man has a depth of 24 feet only. Thus, to hit a standing man on the terreplein, which is generally about 30 feet wide, the men firing should be placed more than 1,000 yards from a covering parapet, 8 feet high.

It is necessary also to use an elevation rather greater than for the exact range, so that the centre of the nucleus or the central trajectory may pass slightly over the crest of the obstacle. It is sufficient, for this purpose, to aim at the crest of the obstacle with the sight for a range of 25 or 50 yards greater than the exact range.*

* As a collective fire would always be used for indirect firing, 50 per cent. of the bullets would always be spread over 160 yards. This will eliminate any theoretical error from using a too great elevation.

In siege trenches, the protected zone against a fire at 2,000 yards, perpendicular to the crest, extends, for a standing man, to the rear of the trench; thus it is not possible to sweep these trenches by a fire directed perpendicularly to this crest.

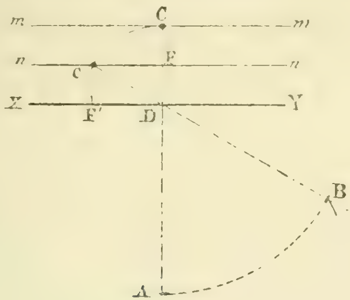

Fig. 28.

Thus, in order to search out these works, it is necessary to fire at the crest in the most oblique direction possible. In fact, we see that, if the fire is executed in the direction BD (Fig. 28), obliquely to the crest XY, instead of in the direction AD perpendicular to it, the lowest trajectories of the cone of bullets, passing over the parapet, strike at C′ instead of at C. The defiladed zone is consequently diminished by the quantity CF, and the zone between the lines *mm′* and *nn′*, which was sheltered from fire perpendicular to the crest, will now be beaten by the oblique fire.

If the trenches or lines of fortifications are not provided with traverses, and can be taken in enfilade, it is not necessary that the trajectories should have a great angle of drop, and thus such an enfilade fire is efficacious at all distances.

Indirect Fire.

By indirect fire is meant any fire directed on objects that are masked from the view of the firers, and which are at some distance in rear of the covering obstacle. Thus the problem of indirect fire reduces itself to this case—viz., to determine the elevation with which one should aim at a visible point, chosen as an auxiliary object, in order that the mean trajectory may pass over the intervening obstacle, and through the centre of the real object.

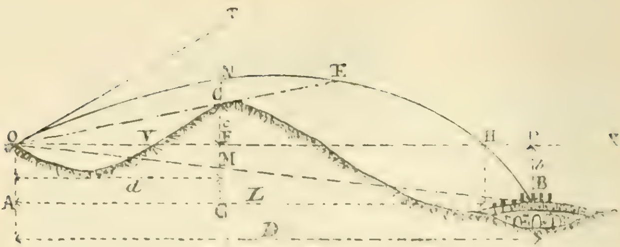

Fig. 29.

Suppose we wish to cover with fire, from the point O (Fig. 29), an object B placed beyond an obstacle C, such as the crest of a hill, a wood, a wall, &c., which hides the object B from the sight of the firers at O.

To be able to make any use of indirect fire, the direction of B from O, the distance OB, and the difference of altitudes of the points O, C, and B must be known from a map drawn to a scale of at least $\frac{1}{80000}$, or about $\frac{3}{4}$ths of an inch to a mile.

From the point O draw the horizontal line OX; this line cuts the covering obstacle in V. If the object B was visible from O, it would be necessary in order to hit it, to aim at it directly with the angle of elevation TOB for the whole range; but the object being hidden, it can still be struck by aiming at an auxiliary point V situated in the horizontal OX passing through O, into the angle of elevation TOH, *provided that the difference of altitude, CF, between O and C, is less than the ordinate FN of the trajectory ONH.*

Instead of aiming horizontally, which offers certain difficulties, we can with advantage use the crest C of the obstacle, or any other well-defined mark on it, as a point or line to aim at.

In this case it is necessary to aim at the point C with the angle of elevation TOE. We must now find on the line OC produced, the position of the point E where the trajectory cuts this line, that is to say, the distance OE, so as to find from it the sight to be used. If OE is less than OC then we cannot fire indirectly until we go to a more suitable firing point.

The solution of the problem depends almost entirely on the relations between the angles TOB, TOC, COX, and XOB, and to determine the relations of these angles to one another *a figure, similar to that of Fig. 29, should always be drawn.* In the above figure the angle TOB=TOC+COX+BOX.

There are several methods of solving the problem of indirect fire, but the best of all is the simplest one, which does not require the use of any formulæ. All that has to be done is to make use of columns 1, 2, and 3 of Table I. p. 8 in connection with an easy arithmetical calculation.

From a map we must obtain the difference of level, b, between B, the object fired at, and the height of the origin of fire at O; the difference of level c between C, the point aimed at, and the origin of fire; D, the distance of O from B; and d, the distance of O from C. The height of the rifle above the ground must be included in the height of the origin of fire. As the map gives only horizontal distances, these can be used for the true distances, without appreciable error, if the differences of level are not too great with regard to the distances separating the different points. If the horizontal distances found in the map cannot be used without appreciable error, then the true distances can be found, from the information on the map, by taking the square root of the sum of the squares of the horizontal distance and the difference of level, expressed in the same units of measure. In the following calculation we shall use the horizontal distances, it being understood that the true distances can be used instead of them if thought desirable.

Dividing c by d, we get the tangent (expressed as a fraction) of the angle which the line of sight, when aimed at the point C, makes with the horizontal. From Table I. we can then determine what this angle is. Similarly by dividing b by D we can find the angle BOX. Deduct or add (according to the figure) these angles from or to the angle of elevation for the whole range OB, and find from the table to within 25 yards, the range corresponding to this new angle of elevation. Then if the sights are set for this range, and aim is taken at the auxiliary point, the enemy will be reached, if a collective fire spreading over 100 yards is made use of.

Examples:—If $D=1{,}400$ yards; $d=700$ yards; $b=100$ feet; and $c=50$ feet.

then $\tan.\text{COX} = \dfrac{50}{3\times 700} = \dfrac{1}{42}$ and $\tan.\text{BOX} = \dfrac{100}{3\times 1400} = \dfrac{1}{42}$

Therefore $\text{COX}=\text{BOX}=1^\circ.22'$, and the angle $\text{COB}=2^\circ.44'$.

But the angle of elevation, TOB, for 1,400 yards$=4^\circ.40'$.

Hence the angle $\text{TOE}=1^\circ.56'$, which is the angle of elevation for 750 yards.

If the angle TOE is less than the elevation for the range

OC, or if the angle COB is greater than the angle TOB, then an indirect fire is not possible under the given conditions, and other more suitable conditions would have to be sought for to enable it to be carried out. Thus, if in the above case $c=150$ feet, then the angle TOE would be equal to 1°.10′, which is the angle of elevation for 500 yards, and consequently the bullets fired from O would not have passed over to point C, 700 yards off. If the height of C was 300 feet, the angle COB would have been greater than the angle of elevation TOB for the whole range, and we could not make use of an indirect fire.

Before we could use an indirect fire in these last two cases, we should have to move the origin of fire, O, further away from the point B, required to be struck.

The elevation found in the above calculation is for a range within twenty-five yards of the true one, but as a collective fire would always be used for indirect firing, this error would not be much felt, from the bullets falling over 100 yards.

We have supposed above that the object is placed on a lower level than that of the firers, but a similar calculation can be applied to the opposite case. The same thing can be done if the point of aim chosen is below the horizontal plane passing through the origin of fire, or is beyond the point to be hit.

In considering the difference of altitudes of the different points, we must take care to increase the altitude of the origin of fire by the height of the rifle above ground, *i. e.*, about three feet for kneeling men, and five feet for standing men.

Indirect fire always ought to be corrected, when possible, by watching its results, by an officer placed in a convenient situation.

Every method of solving the problem of indirect fire depends on all the relations of height and distance between the three points, which have to be considered in indirect fire, being known; but this will only occur in the defence of fortresses and positions prepared beforehand. In the field, the application of indirect fire must be limited to those cases in which the determination of the three points in question can be instantaneously known or estimated with sufficient accuracy. These cases occur when a mounted commander, or one who can place himself in a tree or other high point of observation, can see the enemy, when his troops standing on the ground cannot do so. In such cases, the easiest method to make use of indirect fire is to employ columns 1, 2, and 3, of Table I.

in connection with an easy calculation in the manner already shewn. The difference of level in yards between the point aimed at and the height of the rifles above the ground must be estimated or found with a clinometer, and the distance of the same point in yards estimated or measured. But it must never be forgotten that the efficacy of an indirect fire depends on whether or not its effects can be seen so as to correct the fire. If it cannot, then, in the field, when the supply of ammunition is limited, it is useless to attempt to make use of this kind of fire. It is often possible to post an officer on the covering mass* for this very purpose of observing the fire; he would of course be to one side of the direct line of fire and he must be careful to make his observations in accordance with the remarks given for observation of effects of fire on p. 401.

Indirect fire, however, can rarely be used in the open field.

In defensive positions, and principally in sieges, indirect firing can render great service. But, in order to obtain every advantage from it, it is necessary that the ground over which it is executed should be well known, that some marks should have been put up, and that the altitudes of the different points, as well as their distances apart, should have been measured. This information for the environs of fortified places should be written down in *Firing Tables*.

A firing table contains all information on the different probable points of passage of the enemy (bridges, cross roads, defiles, débouchés, etc.), as well as the corresponding convenient situations for the firers of the defence. It contains also, for each station, the point to be aimed at, and the sight to be used.

Thus we see that indirect fire requires the previous knowledge of certain topographical data in order to determine the point to be aimed at, and the sight to be employed. In the offensive, an occasion to use it will rarely be found; but cases for employing it may occur in the defensive, when there has been ample time to prepare the position and study the ground in front of it.

In siege warfare, however, it may be applied, and be made to render very great services to both the troops of the attack and of the defence.

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* If the covering mass is a hill and is quite close in front, *i.e.*, 200 or 300 yards off, it would of course be occupied in preference, when possible, and a direct fire made use of.

But indirect fire can only be carried out in the field when, by the aid of a sufficiently accurate map, the position of the objective, of the auxiliary point aimed at, of the origin of fire, and of the alignment of these three points are known, as well as the horizontal distance which separates them, and their differences of level. From these data the sight to be used can be determined, which in some cases can be rectified by watching the strike of the bullets.

Another thing we see is, that indirect fire can only be used when the ordinates of the trajectory are sufficiently great to allow of it passing over the height or obstacle which prevents the object being seen, and hence, to execute an indirect fire, the origin of the fire may have to be moved further away from the object to be hit, in order to get greater ordinates. Again, as the powder charge, and consequently the muzzle velocity and angle of elevation for any given range, cannot be altered in rifle ammunition, we cannot fire indirectly on an object unless the range is suitable.

Résumé.

Thus, though long range fire can be executed on unseen objects, yet it necessitates a thorough knowledge of the ground, and of other particular conditions, and hence this nature of fire is impracticable in war, except in two special cases:—

(1) When the fire is inclined, by which, when firing from a valley or plain on to the crest of a plateau, a dangerous zone is obtained by indirect fire much deeper than on ground parallel to the line of sight, by which the direct shots, aimed on the shooting line occupying the edge, may strike the supports and reserves in rear. When, however, the defender withdraws himself from the edge of the plateau, the power of using inclined fire passes to the defender, who then, by his direct fire on the enemy's shooting line, when it reaches the crest, may cause loss to the enemy's echelons in rear. We have already discussed the question as to the advisability of trying to make any serious use of this kind of fire.

(2) When the fire is dropping, the objective being a fortification; but the effect of this fire will be somewhat modified by the modern use of traverses and blindages.

It is in fortress warfare, as pointed out by Von Boguslawski and chiefly on the side of the attack, that a long range dropping rifle fire will be principally used in the future. The infantry

of both sides will no longer be reduced, as of old, merely on the one side to fire on the attacker's sap heads, and on the other on the defender's embrasures to keep down his artillery fire by harassing and decimating his gunners. But it will have in the future, a more extended *rôle*; infantry can now combine its fire with that of the siege artillery, and help it by sweeping the ramparts, and rendering them for a time, untenable by the garrison.

This use of rifle fire seems destined to give important results against detached forts, and more especially so against isolated works, particularly those which can be surrounded, when detachments can be so placed as to enfilade the faces of the works and compel the garrison to get under cover. The musketry fire from the ramparts of modern forts is often very weak, from the number of traverses and guns, which take up so much space, and hence the fire of the attacking infantry, putting artillery fire out of consideration for the moment, can only be returned with effect from the covered way or from shelter trenches placed in front of the works, or from a low parapet placed in front of the main ramparts, affording to the infantry sufficient space to deploy. If the Russians had employed long range fire in the manner indicated above, at Plevna, it would have considerably facilitated their attacks.

It has been already stated that long range infantry fire should be concentrated on the same objective, and used by masses (*i.e.*, large bodies of troops) only, and if used judiciously in such a manner it must prove of the greatest advantage in fortress warfare and will be a great assistance to the fire of artillery.

In a siege, long range fire being used by well-covered detachments at exactly known ranges, and on a clearly defined object, very easy to aim at, the rifles being rested on boards, etc., (see Figs. 30 and 31, p. 241), its results cannot be compared with a similar fire in the field, where the infantry are exposed to all the excitement of battle, and where the fire has to be directed on a moving adversary who can only be seen at short intervals, at unknown or imperfectly known and continually varying ranges, and at no clearly defined objective. Again, in siege warfare, the siege train of the attack can bring up an unlimited supply of infantry ammunition, while the supply of ammunition to attacking troops in ordinary field warfare, is a very difficult problem to solve satisfactorily. A body of infantry, extended in prolongation of the face of a work, could, by the use of several sights,

cover its whole extent with fire. An enfilade fire dropping about 1 in 14 (from 1,000 yards) and a plunging fire of about 1 in 4 (from 2,000 yards) could be used together on a fort; they would prevent the garrison from moving freely on the ramparts, and would take in reverse its rear faces even over any parados that may exist. If every man fired 100 rounds per hour, a battalion of 800 muskets would pour into the fort a mass of 160,000 bullets in the space of two hours, which could not but have a most telling effect, unless the fort possessed more than the usual amount of casemates and blindages.

At the commencement of an attack on large entrenched camps, the *rôle* of infantry will also now-a-days be still more considerable than formerly. The detached forts surrounding such camps will be joined by lines of trenches and batteries of position. The besieger, by appearing suddenly before the place, and by seconding the fire of his first siege batteries with a heavy infantry fire may, perhaps, be able to so sweep the ground between the two or three forts chosen for attack as to prevent the besieged from maintaining or reinforcing these intermediate lines. Under these circumstances, Von Boguslawski thinks that the besieger may be able to penetrate by main force through the line of exterior defences, and completely surround one of the forts, when it can be attacked like an isolated work, in the manner described above. To effect this purpose it is of course assumed that the besieger can dispose of greatly superior forces, and so to employ infantry in masses against the intermediate lines of the defence will, it is considered, be the most effective manner of using the preponderating force.

This is in principle nothing but a reproduction of the ordinary conditions of an attack on a defensive position in the field,—a heavy fire disorganizing the defence and preceding the assault. This distant fire, from not having the same efficacy as fire at shorter ranges, and from entailing a great consumption of ammunition, should only be looked upon as a help to the artillery to disorganize the defence, and so prepare the assault. Under these circumstances, the passive obstacles presented by fieldworks being but slight, the lines which a distant fire has compelled to be more or less evacuated, may very possibly fall before an attack rapidly executed in great force.

Against the forts themselves these results will be much less, since distant infantry fire, although it may inconvenience the

defenders, cannot prepare the assault, because even supposing the defenders driven from their parapets, the assaulting columns would be stopped by the passive obstacles (deep ditches, scarps, etc.) undestroyed by artillery fire, where they will be fully exposed to the unsubdued fire of the flanking defences. This does not of course apply to works without any ditch-flanking defences, such as the Turkish defences at Plevna, and which were therefore open to assault.

Even if it be found impracticable to employ infantry in the above vigorous manner, yet there can be no doubt that the duties of infantry at the commencement of a siege will be much transformed and developed in the future. Hitherto its action has been more passive than active, the duties of infantry having been chiefly confined to investing the fortress, and protecting the exertions of the first batteries ; but now owing to its improved weapons, its action will become more active. For this reason, Von Boguslawski insists upon the necessity of instructing both officers and the rank and file in the employment of indirect fire, and proposes to create a special siege infantry, just as there is a special siege artillery.

A writer in the German military paper, the *Militär Wochenblatt*, for February, 1885, in discussing the question of indirect infantry fire, is of opinion that its effect in the field is generally open to question, as it leads to great expenditure of ammunition, with but doubtful results. The modern rifle, he considers, with its low trajectory, is seldom suited to its employment, except at long ranges, and where troops are known to be concealed in shallow depressions of ground ; on the other hand, if operating against troops protected by siege works or field entrenchments, direct rifle fire is of but little use, unless the enemy exposes himself above the parapet, and the only means of reaching the mass of men who are sheltered within the works is by employing artillery fire. It is much to be desired that some means should be devised to make rifle fire effective under such circumstances. The profile of ordinary siege works protects the men against fire with a less angle of descent than 15°, and as the rifle, even at a range of 1,700 yards (the maximum distance for which the German rifle is sighted), has only an angle of descent of about 11° to 12°, it is of little use against men under cover. The maximum range of the rifle is reached with an elevation of 35° and any attempt, with the present ammunition, to use it with greater elevations so as to clear the parapet at shorter ranges, would probably prove futile, on account of the height to which

the bullet would rise, and the increased resistance of the air making the fire uncertain. Hence the writer of the article referred to above, thinks that experiments should be made to ascertain whether this inconvenience could not be overcome by employing a special cartridge with a reduced charge of slow-burning powder. The advantage that would be derived from the employment of indirect infantry fire during siege operations, when the distances can always be accurately ascertained is so great, that this suggestion is worth consideration.* It would, of course, be necessary to have a supplementary sight, that would allow of the proper elevation being given for certain ranges, and precision might further be secured by firing the rifle from a rest. The additional sight need not form a permanent feature in the rifle, but need only be attached when required. Special elevation tables would answer the same purpose.

Direct and Indirect Aiming.

From the foregoing we see that fire can be executed in one of two ways:—

1. By aiming directly at the object to be hit with the proper sight for the distance, called *direct aiming*.
2. By aiming at an intermediate object, in line with the object to be hit, with such a sight as will ensure the given range,—the point aimed at on the intermediate object being such as will ensure the bullets passing over it and not being stopped by it; this is called *indirect aiming*. How to find the proper elevation for indirect aiming has been already given under the heading of "Indirect fire."

In some experiments on indirect aiming, carried out by the Siege Operations Committee, a pole (with a number on it) was set up for each man, or a strip of canvas was hung up on a supported wire about five feet and a-half from the ground, with small numbers painted on it at intervals of about two feet, along the top edge, and numbered so that

* Artillery has had to solve the problem of using guns for both indirect and direct fire in sieges, by employing a special kind of gun for each nature of fire. A similar method might be adopted for infantry fire, the special rifles and ammunition being attached to and brought up with the siege trains.

each man might always know at what spot to aim; a plank supported on upright posts would do as well. The men were placed at such a distance in rear, that when lying down and aiming with certain sights at the marks, the elevation for the range was obtained, and also the required direction. It was found that the longer the range the better were the results, as far as the intensity of fire on a given area was concerned, because the effect of small errors of elevation tell less as the range increases. The general result, however, of the experiments showed, that when the object to be hit can be seen, direct aiming is the best, and that owing to the trouble of preparing for the indirect method, it would seldom be applicable in the field.

Indirect aiming is only adapted for the case when a large area is to be covered with bullets, when the objects on it cannot be seen, or only very indistinctly, or when the rifle is not sighted high enough for the range; hence its principal application is in siege warfare.

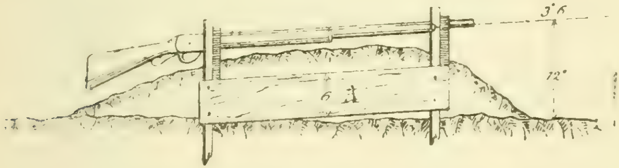

Fig. 30.*

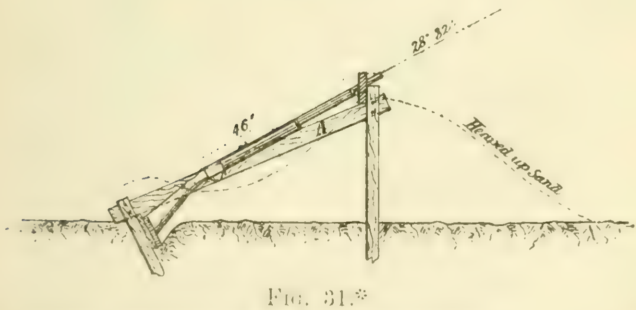

Fig. 31.*

* The rifles may be placed 30 inches apart; the cross-pieces, marked A, should be 4 to 5 feet apart.

In some cases, as in a siege, when the slopes and form of the ground may be known or found out, in firing at long ranges, the method of using rests for the rifles can be very well applied, as it increases the accuracy of a fire to a wonderful extent. The rests can be formed of rough boards, both notched as in Fig. 30, or one notched to take the rifles, and the other so fixed as to form a rest for the butts, as in Fig. 31. These rests should be fixed close to the surface of the ground, and weighted with earth, &c., to ensure steadiness. Up to the limits of the backsight, the rifles can be either laid directly on the object, or indirectly on an auxiliary point, or the elevation may be given by a clinometer; for ranges over the limit of the backsight, a clinometer or a special sight must be used. Effect of wind can be provided for by means of wedges. "Rough-and-ready as this method is, the results obtained, promise, in the attack and defence of works, an extremely simple, and, as regards quantity of ammunition consumed, a cheap way of annoying the enemy, or even of aiding the fire of artillery, particularly when the object fired at cannot be directly seen" Such a method also is excellent for night firing (see below), the elevation and direction having been ascertained during the day time. One or more elevations can be used, as thought necessary, but to ensure the efficacy of any long range fire, the range should be exactly known, which is usually the case when such expedients as the above can be resorted to.

In the lectures laid down in the English musketry regulations, we find the following:—"In the attack or defence of fortified posts or positions, you may often be required to keep up a fire on a particular point after darkness has set in. In this case you may effect your object by planting, *during daylight*, two stout forked sticks firmly in the ground, so arranged as to relative height and direction (by the aid of sights properly adjusted), that when the rifle is laid on them, it will have the necessary elevation and command the desired point; or the same object may be obtained by means of sandbags or large stones properly arranged.

"During the daytime, you may, by a somewhat similar expedient, keep up a continuous fire on bodies of the enemy's troops, who may from time to time be temporarily obscured by clouds of dust or smoke drifting across the front and concealing them. In this case, during a clear interval, having marked your own position, you should plant a single stick or rod in the ground a short distance in front of you, so that the

top of it may be in line with your eye and the object at which you are firing;* you can then, when the enemy becomes obscured, keep up an efficient fire by aiming at the top of the stick."

Night Firing.

Experiments made by the Siege Operations Committee in 1879, in night firing with volleys (see p. 385) without the use of sights (which could not be seen) both on dark and moonlight nights, with the rifle simply rested and otherwise, and the men in various attitudes, with bayonets fixed and off, showed excellent results up to 600 yards, but beyond this distance no certain results could be depended upon. As the sights could not be used, the elevation was judged, but as the dangerous zones up to 600 yards are very great, a great depth was swept, from so many errors made in judging the elevation. The lying down position gave the best results, and fixing the bayonet seemed no disadvantage, while it would give great moral support in war. Whitened fore- and back-sights are good for night firing after dusk or darkness has set in; this is best and simplest obtained by tying white rags round the barrels over these sights.†

With artificial lights (as fires representing bivouac fires) and with the electric light, much the same results were obtained up to 600 yards.

Night firing from rests, the rifles being laid during the day on the object, which might be any point over which the enemy must pass to reach the defenders' position, gave good results, and the remarks on firing from rests, given on p. 240 apply equally well to night firing.

From the deadliness of modern fire over ground that can be seen, many tacticians have come to the conclusion that in the future, night attacks will have to be resorted to more than ever, so as to be able to approach the enemy to very close ranges under cover of darkness. In these night operations close order formations will play a great part in order to main-

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* If the exact position of the eye is not fixed, two sticks or rods should be put down, the tops of which are both in the required line.

† When firing at night, the men should be taught to shut the eyes at the moment of firing, because if they do not do so, the sudden glare of the flash so dazzles them that they cannot see to fire again for a minute or so.

tain the necessary control over the men. The whole success of the attack depends on secrecy, surprise, and rapidity of action, while the security of the defence depends on early information secured by a good outpost service, on every man knowing and being able to rapidly take up his allotted position, and on the destruction, demoralization, or weakening of the enemy before he can close with the defenders. This latter point the defence can only effect by fire, and to fire with efficacy they should be able to see the enemy as soon as possible.

If the defenders should fear an attack, General Brialmont thinks that they should light fires of brushwood at nightfall on their front and flanks, and keep them up during the night. Behind these the sentries and picquets are to be placed, who are to show a lantern or to fire when the enemy appears. By the light of these bonfires,* the defending troops are to fire on the attacking columns.

In Afghanistan, at some of the posts on the line of communication, the superior slopes of the parapets were made parallel to, and nearly coincident with, the ground outside the fort, so that rifles rested on them would sweep the ground in front, without any aiming, in case of a night attack. At Tel-el-Kebir the superior slopes of the Egyptian entrenchments were horizontal, and this must have been one great cause of so little loss among our troops, as the bullets must have passed over their heads.

In the Franco-German and Russo-Turkish wars, several night attacks on both sides were repulsed by fire.

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* General Brialmont says, these fires should be 2,000 yards to the front, but English experiments have shewn that no reliable results can be got from night firing at over 600 yards. If the fires were at this latter distance, the sentries should be beyond them and hidden, because when the fires are within the line of sentries they can be better kept up, for if they are on or in front of the line of sentries, as General Brialmont suggests, the enemy might send out picked marksmen to shoot down any one attempting to feed the fires and then wait until they went out before attacking.

CHAPTER XII.

LONG RANGE VERSUS SHORT RANGE FIRE.

In drawing any conclusions from certain facts that happened in the wars of 1870-71 and 1877-78, we can only make deductions as to what will occur when the opponents are equal in numbers, in tactical and fire instruction, in armament, and in discipline. In both the wars quoted, there was inequality in every one of these points.

In the Franco-German war, the Prussians were superior in administration, numbers, instruction, discipline, and in artillery, but were armed with a much worse rifle. They entered the campaign with the idea that the attack, after an artillery preparation, was to be carried out by a line of skirmishers, followed by closed columns of attack.

In the war of 1870-71, the history of every action that took place shows, that the commencement of an infantry attack was broadly conducted thus:—The infantry advance was first of all prepared by a concentrated fire of artillery on the main points of attack, which served in great measure to shake the hostile force, and lessen its power of resistance, after which followed the infantry attack. When a sufficient artillery preparation was not carried out from using too few guns, or for want of a good artillery position, as at Spicheren, or where it was not effectively ensured, as in the attack of the Prussian Guards at Gravelotte, we find that, either an enormous loss was sustained, or the attack was brought to a standstill. The attack formation of each of the two brigades of the Prussian Guards at St. Privat, when they suffered so fearfully, consisted of an entire battalion extended in front as skirmishers, followed by two lines of half-battalion columns in rear.* When it was possible to push on without having to extend, the formation usually employed by the Germans was that of company columns.

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* Since the Franco-German war the battalion attack formation has been altered. It now consists of two companies, side by side, in advance, with a third of each extended as skirmishers, and the remaining two-thirds in support, while the other two companies, massed in rear of the centre, followed as reserves, separating from one another as they came under the influence of the enemy's fire.

It was soon found that, whatever the original formation of the troops may be, there was only one form admissible under fire,—skirmishers, supports, and reserves will all soon take up extended order to avoid useless loss, and unless great care is taken, will merge into one shooting line. There are two reasons for this last fact, (1) because men do not like being fired at without firing back in return, or in being killed by the enemy without a chance of killing him, and this leads to the supports and reserves, thrown out of their close formations by the fire of the enemy, rushing forward to their comrades in the skirmishing line to join them in crushing the enemy by their fire; (2) because there is the innate desire to get to a range of 300 to 400 yards from which alone the men feel that they can fire with decisive effect. This course of action was greatly facilitated by the continuous fire kept up by the skirmishers, which rivetted in a great measure, the fire of the defenders, and thus aided the advance of the troops in rear, who were, as a rule, only too anxious to rush forward.

Before 1870, the Germans had only fought against moderate-ranged, muzzle-loading rifles, and at the time of the Franco-German war, it was laid down that fire could only be considered effective at close ranges under 440 yards (the Prussian rifle being then only sighted up to that distance), and that therefore every effort should be made to get the troops within that range before commencing the fire fight. The Germans, however, soon found that the French were armed with a vastly superior weapon to their own, and that they also made use of an entirely new feature in war—a rapid, long ranging infantry fire. Its dissolving effect on the close order formations first used by the attacking troops was very great, and was felt early in any action, both supports and reserves being reached by it. No mere extension of the weak firing line first used was sufficient to cover the advance of the troops in rear, and hence it was found absolutely necessary both to extend the troops in rear and to engage a number of rifles, at least equal to the number used by the defender, so as to crush his fire, and thus to enable the troops in rear to advance. The feeble skirmishing line at first used could not get on without reinforcements, which were soon required by the heavy losses caused by the enemy's fire, and thus the supports quickly became absorbed into the skirmishing line. Then if the losses were still severe, or if the advance was checked, the reserve also joined the firing line, all alike eager to get near enough to the enemy to return with effect

his fire, which they could not stand without reply.* Often, too, a rash advance of the firing line drew on the troops in rear to extricate it from danger. The skirmishers, instead of being, as originally intended, merely a screen to cover the advance of the closed main body, intended to carry the position, now became the real fighting line, which for the reasons already given, became made up of various companies and battalions, or even of different brigades well mixed together, and who always carried the positions in dispersed order. This fighting line was, however, composed of distinct groups, formed anyhow by the energies of the officers, and which were kept together and impelled forwards only by the example of the officers and non-commissioned officers leading them, and by a mutual desire to act in common support of one another against the enemy.†

Such a line would, and very often did, sway backwards and forwards, as it felt the pressure of the enemy's fire, and as it was carried on by the impulse afforded to it by any fresh troops sent into it from the rear. It alone won the victory, and there is no example in the wars of 1870–71 and 1877–78 of its merely preparing the way for the advance of troops in closed formations. The official accounts of the battles of Wörth, Spicheren, and the fighting round Metz, give accurate and vivid descriptions of this method of fighting, and typify the conduct of troops under the influence of modern rifle fire, when unprepared for its terrible dissolving effects.

The immediate tactical outcome of the war of 1870-71 was then, as far as infantry are concerned :—

1. The actual fighting must be done by the fire of troops in dispersed order, supported by other troops in rear also in extended order if necessary, but if possible, in close order.‡

2. The *decisive* fire zone extends only to 400 or 500 yards from the enemy, and every effort should be made to prevent the attacking troops opening a serious fire until they reach this distance.

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* The Germans apparently do not admit this, for in their latest Musketry Regulations they state :—"A well-trained infantry ought to be capable, at a given moment, to stand firm under the fire of the enemy, without returning a single shot."

† Throughout the whole account of the Franco-German war, we constantly read of German officers offering help to, or demanding it from, one another.

‡ As to the advantage of close order over extended order formation, see p. 448.

This second deduction shows that the long range fire of the French was treated as unaimed fire, which would occasion loss to, but could never stop, a well trained and disciplined infantry. The wild confusion which occurred in the German attacks was not accepted as a tactical necessity, because they were produced by the unexpected efficacy of modern fire, by the rashness of the German attacks, and by the German troops not having been sufficiently trained to this kind of fighting.

But it must be remembered that the Germans were armed with a far inferior weapon to the French, and also that the latter, though making use of long range fire, had never trained their troops in its proper use. Thus, though we may admit the tactical formations deduced by the Germans, yet, from the facts of the war of 1870–71 alone, we need not do so with regard to the use of the rifle, for it may be possible to instruct troops in the use of aimed fire, other things being favourable, at ranges considerably beyond those stated above.

Every one acknowledges the desirability of arriving at an effective range before commencing the real fire fight. But what is an effective range? Frederick the Great said, when the whites of the enemy's eyes were visible. Our Peninsular victories were gained by a judicious use of infantry fire at even then close ranges, and now-a-days better shooting can be made with the Martini-Henry rifle at 1,000 yards than with the old Brown Bess at 100 yards. Improved fire-arms have increased both the range at which, and the readiness and facility with which, fire may be opened and kept up, and the consequence of this has been, not only to replace the old shock tactics by fire, but to increase the so-called effective range.

All Continental nations say that the time has now come when infantry may open fire at ranges undreamt of before 1870. The French, when they began the war of 1870-71, knew that their rifle was superior to the German rifle, not only in accuracy and rapidity of fire, but more especially in range. There was, consequently, a natural tendency to fire as early as possible at the enemy (which was further increased by the outlet which the bold French spirit, being kept on the defensive, found by so doing), and to overwhelm him with a storm of bullets before he could approach to the assault, that is at a time when, by the inferiority of his weapon, the enemy was unable to reply. Thus the French kept up an incessant fire at long ranges, but with no *fire*

discipline (see Chap. XV.), which led to a large amount of this fire being unaimed; rifles were even fired from the hips without aiming, the consequence of which was, that though the ground in front of the position was more or less swept with bullets, up to a distance of 1,600 yards, yet it caused the Germans to suffer less and less as they got nearer to their adversaries, from the mass of the fire passing over their heads.* Nevertheless, unaimed as the long range infantry fire of the French was in a great measure, yet it, on many occasions, *when opposed to plainly seen dense formations*, caused severe loss to the Germans, as happened to the Prussian Guards at St. Privat, who, in less than thirty minutes, lost a third (6,000 men) of their number by a rifle fire at ranges varying from 600 to 1,500 yards. They suffered so that they did not make any further attempt to get nearer than 600 yards to the village until the French artillery had been silenced, until St. Privat had been shelled by nearly 160 guns for some hours, and the French had used up all their ammunition, and until the French right flank, which rested on the village of St. Privat, had been out-flanked and turned. Nearly all accounts now agree in attributing the French retreat from St. Privat to want of ammunition, which prevented them from continuing the fight on equal terms. At first the formation of the Prussian Guards was very deep and close, but the French fire soon dissolved it into a deep skirmishing line.†

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* The cause of this fire going high may also be partly ascribed to the French troops not altering their sights, and to their aiming at the centre of the enemy's bodies, as they were then trained to do (see Plate I.), and partly to the fact that men are apt to fire high when firing downhill.

† At the battle of Gravelotte, on the 18th Aug., 1870, of the German losses, 94 per cent. were due to the French infantry fire, 5 per cent. to artillery fire, and 1 per cent. to swords, lances and bayonets. But nothing is more misleading than numerical data without stating the conditions under which they were obtained. The French artillery was badly used, and silenced early in the fight, and consequently the Germans suffered an exceptional percentage of losses from infantry fire. Bearing this fact in mind, which applies to almost every battle in the war, the following comparative statistics have been given for the war of 1870-71, based on the wounded admitted into hospital. On the German side 88 per cent. were wounded by infantry fire, 5 per cent. by machine guns, 5 per cent. by artillery, and 2 per cent. by swords, bayonets, and lances. On the French side 70 per cent. were wounded by rifle fire, 25 per cent. by artillery, and 5 per cent. by swords, bayonets and lances. Further, in comparing artillery and infantry statistics, to obtain a comparative value of the two arms, we must take into account the invariable numerical superiority that infantry always have. Taking these facts into account, modern artillery fire compares very favourably with infantry fire, especially when modern shrapnel fire is used.

On the other hand, a writer in the *Bulletin de la Réunion des Officiers*, states that in the campaign of 1870, at the battle of Wörth, "the long range fire of the French had but a poor effect, but when the distances diminished, the Germans suffered great losses"; and again at Spicheren, "the fire of the division Laveaucoupet at long ranges produced no appreciable effect."

But this fire of the French troops was unaimed and uncontrolled, and hence far greater results may be expected from a controlled aimed fire, carried out by infantry trained to its execution, which the French certainly were not. Even in spite of this a French writer says:—"The Germans complained, in general, of great losses suffered during the war at considerable distances. At close ranges, on the contrary, *the small amount of instruction in rifle fire that the greater part of the French troops had received, annihilated the superior qualities of their rifle.*"

The value of long range fire against closed masses of troops received a further proof in the Russo-Turkish war of 1877-78, in which the defeated side was again much better armed. The fire tactics of the Turks consisted simply in firing at all distances up to the extreme range of their rifles as quickly as possible, and the consequence of this, was, that at even 2,500 yards the effect of infantry fire began to be felt,—"the infantry fire fell like a rain of bullets" at this distance, as General Todleben said, and again "the fire of the Turkish infantry fell like a hail at distances over 2,400 yards. The most heroic efforts of our troops were without result. Divisions of 10,000 men were reduced to 4,000 or 5,000 men." At 1,700 yards the losses from this fire became considerable, and as the distance decreased, the fire grew hotter and hotter, till it became a perfect rain of lead, "only to be pictured by those who went through it." The Russian Guard suffered at Gorny Dubniak in a similar manner to the Prussian Guard at St. Privat, and for the same reasons,—*from having used deep close formations before the enemy had been sufficiently demoralised*, and so made to fire wildly. Usually the long range Turkish fire, in the earlier battles of this war, contrary to German experience against French troops, became more deadly at the nearer ranges, than it had been at some distance further off, and the actual attacks were consequently carried out with frightful loss, especially as the Russians retained their close, dense formations under short range fire even to the end of the war. But this

increasing effect of the fire was only experienced in the earlier battles when the Russians did not fire while they advanced; in the later battles, however, when they did fire while advancing, the Russians, like the Germans, experienced less losses as they approached the enemy.* This is another reason for allowing the men to fire while advancing, but under strict control—to intimidate the enemy and make him fire wildly. The Turkish infantry were armed with a good rifle (the Martini-Peabody), but were essentially uninstructed—a large proportion of them being even perfectly ignorant of the proper use of the sights—and if, as there can be no doubt, their fire, in great part unaimed in the true sense of the word, could cause such fearful losses, it stands to reason that had the Russians been opposed by better trained soldiers, their losses would have been far greater. "The opinions on the efficacy of the Turkish fire at long and short ranges are very variable. Some writers say that the Turks fired very little at long ranges, and reserved their ammunition to make a terrible fire at short ranges; others assert the contrary. Perhaps both statements are true; but the first applies only to the regular and disciplined Turkish troops, who obeyed the orders of their officers. In general, the Turks did not spare their ammunition, but, if they fired at long ranges, the fire of the disciplined troops at short ranges lost nothing of its efficacy when the soldiers waited until the enemy was close, in order to open suddenly an intense fusilade. The second statement applies only to the irregular troops, who were placed behind epaulments, with abundant ammunition which they used and abused; it is certain, however, that the rain of lead they sent at great distances caused some losses." The value of long range fire, *when executed under favourable circumstances*, is thus shewn by experience. It is, however, only fair to remark here, that the Turkish system for the supply of ammunition to the troops in action, was perfect. With them there never was any want of ammunition, as every man had more than he could fire. But such an organization is not ever likely to occur among civilized troops who require more personal impedimenta than did the Turks, who only carried food and ammunition. Further on we shall see that this question of supply of ammunition has a most important bearing on the question of long range fire.

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* See footnote on p. 249, which applies equally in this case.

The Russo-Turkish war is a marvellous example of how a great army failed to profit by the lessons taught by the experiences of 1870-71. The Russians had a bad rifle,* and bad artillery, they relied on shock tactics, putting little faith in infantry fire, and consequently they kept their men in closed formations of considerable size, which formed enormous targets to aim at, and in these formations they tried to close with the enemy to attack him with the bayonet. They made no use of cover, but simply laid down where halted. The losses were fearful; the infantry dashed on over long distances in the open without firing, and with immense bravery, but only to be slaughtered down; the tactical units got dissolved and mixed up, and the advance became disorderly, the disorganised swarm passing out of the control of their leaders. When the men did fire, in the advance in the earlier fights, against orders, it was just how they pleased, and it was usually a sign that the force of the attack was spent, and that a retreat was impending, unless fresh troops were at once brought forward. Besides this, their attacks were often undertaken with too small a force, and the fundamental rules for a successful attack were nearly in every case neglected, viz.: the preparation by a preponderating artillery fire and a flank attack combined with one in front. The Russians nearly always attacked simply in front. Both the artillery and infantry were badly used, and, with what fire there was, there was no attempt to concentrate it, and the artillery often opened at impossible ranges, and did not advance to support their infantry during the attack.

On the other hand, on the only two occasions in this war, in the attacks on Nicopolis and Lovtcha, where the artillery and infantry were properly used, the attacks were most successfully carried out with comparatively small losses.

The Turks on the other hand, had a good rifle, but were perfectly untaught or uninstructed in its use, but they had unlimited supplies of ammunition, and supplemented accuracy of fire by quantity. Under these conditions they inflicted the severest losses known in modern history on their opponents, at long ranges up to 2,500 yards.

Neither the French nor the Turks had any instruction in making the best use of long range fire. In both cases it was used in a wild uncontrolled way as a possible method of

* The Russian rifle was only sighted up to 600 paces (500 yards). Later on in the War, extemporised sights for longer ranges were used.

breaking the force of the attack before it became dangerous, and when it was directed on deep closed formations, this result was invariably attained, but when it was directed on lines, even dense ones, of skirmishers, it never stopped a resolute advance to the shorter and decisive ranges. But what will be the effect of a well controlled long range fire against such formations cannot be definitely stated until the next great war, though it may be conjectured from experiments made in peace time, and from what it has already done in war.

The first question to be solved with regard to long range fire is, whether it should ever be used in war?

When infantry was armed with a muzzle-loading rifle, there was good reason to place every reliance on the effect of close range fire. Rapidity of fire did not exist, and the weapon was inaccurate at ranges of even 200 yards. The attack was made in closed formations (chiefly columns which advanced without any or very little firing, so the defender's fire was reserved till the attack was quite close, and then it was usually decisive. But now the attack from the power of the modern breech-loader, is exclusively made in extended order and a powerful fire is brought to bear on the defenders for a considerable period of time. No closed bodies are offered as targets at anything like close ranges, and by far the best objects to fire at, both for moral and tactical reasons, are formed by the firing line of the enemy and its supports. To reserve all fire against these until they reach ranges at which the old rifle could have effectively crushed them, would be to wilfully throw away the advantages of the new ones, namely, accuracy at long ranges and rapidity of firing. The experience of two campaigns has shown that with modern weapons, even unaimed, undisciplined fire is capable of giving, under certain conditions, great results at long ranges; and if, therefore, we can employ a well-aimed and controlled fire at these ranges, we may expect to obtain far greater results under the same conditions.

"The long range fire of infantry is not powerful enough to play a decisive *rôle* in war; nevertheless, as in certain conditions, it can exercise a serious influence on the issue of fights, it is necessary to understand it well, as much to preserve oneself from its effects as to make a useful employment of it against the enemy. Let us examine, therefore, the results of experiments, the conditions under which these

experiments have been made, and the results obtained; we shall then be able to state the efficacy of this fire, and deduce from it its application in war."—(C.C.J.) This examination has been made in the last chapter.

The modern rifle can kill up to its extreme range of about 3,400 yards, while on the practice ground it can carry with accuracy to over 2,000 yards, when the distance is exactly known, and even a "chance fire" (see p. 136) from it is far from useless, and may cause serious loss, provided the ammunition can be spared.

But contending lines, when close to each other, fire for the most part wildly and too high, because the men are too nervous to take steady aim.

At long ranges, on the other hand, men can fire with more coolness, and, therefore, steadiness, and exactly as required, but the fire is not so effective. But no battle has been won by long range fire; it has only been decided at the short ranges.

Besides, in long range firing, the question of eyesight comes in. As Lord Wolseley says:—"Taking a mass of men—because an army is a great mass of average men—I believe, out of every 1,000 soldiers in any army, you will find that 10 per cent. cannot even see at 1,000 yards, much less hit an object at that distance." This is another factor that tends to reduce the efficacy of long range fire.

The modern rifle can kill at ranges so great that aiming is impossible, from the eyesight not being powerful enough to distinguish the objects aimed at; though, under favourable circumstances, where the ground is known, and time is available for the necessary arrangements required for it, rifles can be laid on rests or boards, giving the proper elevation for the required range, and the men can fire from such a rest in the required direction. This will cover a certain extent of ground with bullets, but much less so than if the rifles were fired from the shoulder. This method, however, can only be employed for troops in permanent entrenchments, as in sieges, firing on an enemy's battery, or other considerable mark. It may also be used for night firing, so as to sweep the ground in front, should any night attack be expected.

Having in the last chapter shewn the power of infantry fire at different ranges, under the most favourable conditions, the question for decision is—shall infantry fire up to the full range of the rifle, or shall it reserve its fire for more effective ranges?

There can be little doubt that if troops on *the defensive are*

provided with plenty of ammunition, know the ranges, have a good view of the ground in front, and are skilled in the use of the rifle, it would be throwing away an advantage of the defence not to use the power of the weapon at long ranges, *if fitting objects,* such as an enemy's reserves, in large, close formations, show themselves. *But such a fire must always be kept under strict control by the officers, and it should be regulated by the probable effect it will produce, by the quantity of ammunition available, and by the facility for replenishing it. Further, for long range fire to be effective, the ranges should be known with fair accuracy,* and this advantage the defence usually has.

On the offensive, the moving troops are constantly changing the range, and, as we shall see (Chapter XIII.), *are unable to replenish their ammunition to anything like the required amount,* and thus it would be unwise to waste cartridges by shooting unsteadily over an ever-changing, and, consequently, not accurately known distance, and, therefore, *in the attack, long range fire should only be resorted to by special troops,* either taken from troops of the reserve judiciously posted on ~~high positions~~ in rear, to cover the advance of the actual attacking lines, by firing over their heads, or by troops thrown out at first to carry on a temporising fire-fight until the main body is ready for action.

Although opinions greatly differ as to the manner of employing long range fire, and the ranges at which it should be used, yet all own that when judiciously kept under control, it *may* inflict very serious loss to the enemy.

Up to 1870 the efficacy of the independent fire of the average individual soldier at all ranges was looked upon as the criterion for the effective fire of the whole body, and thus any fire over 400 yards was considered unadvisable, as a single man's chance of hitting an opponent was so small beyond that range with the rifles then in use. In fact, the Germans, in 1870-71, when on the defensive, tried always to obtain a clear field of fire of about 400 yards only, and reserved their fire for that range with an invariable success in stopping the enemy's attack. But this war and the war of 1877-78 have shown that *it is the fire of masses of troops, and not that of individuals, which has to be dreaded,* and, therefore, as the effect of fire beyond 400 yards is due to a *certain proportion* of the bullets fired at a named objective taking effect, such fire should not be independent, but should be controlled and delivered only at the command of the leaders of the fighting units, in order to increase this certain proportion as much as possible.

The main arguments against long range fire are:—

1. That the proportion of misses to hits, and, therefore, waste of ammunition, is very great, and hence it would be better to reserve the fire for ranges where the proportion is more favourable.
2. It involves a great expenditure of ammunition—greater than can usually be supplied—and, therefore, the men may run short of cartridges at or before the decisive moment of the struggle arrives.
3. It is fatal to the offensive spirit, which is so necessary to success.
4. Large columns and other objects of large dimensions, against which only this kind of fire is known to be effective, are less and less seen on the battle field.
5. Firing at the same object with sights set for different ranges, which must be done when the ranges are not accurately known, and if any certainty of effect is to be ensured, is the negation of efficacy of fire.
6. That if the men are allowed to fire at long ranges, their fire will decrease in efficacy as the enemy approaches the position.

1. With regard to the first objection, we have little or no statistics based on experience of actual war, as to the "useful effect" obtained by troops who have employed long range fire in the field, but we have a large mass of information obtained from experiments made abroad, which, of course, will not absolutely represent what may be expected in war. It is said that the useful percentage of shots fired in actual war varies from 1 to 12 per cent. of those of peace practice, because on the battle field ranges can rarely be ascertained with anything like accuracy, and the required elevation to be given varies very much with the weather, wind, &c. In France, Italy and Germany it is considered that only about one-tenth of the results obtained in peace experiments can be counted on in war, which estimate we shall accept in future, on account of the authorities it emanates from.

Since 1870, experiments have been carried on in Prussia to ascertain the actual value of long range fire, under conditions resembling, as much as possible, those of war. In these experiments, a solution to the following questions was aimed at:—

(a) Has long range fire any value in war, when directed against a visible or invisible enemy?

(*b*) If so, how should it be applied, by independent or controlled fire?

(*c*) If the latter, what regulations are required to maintain the fire discipline necessary for it?

The reply to (*a*) has been in the affirmative, under certain conditions, which will be stated presently; with regard to (*b*), slightly better results were got from independent than from controlled fire, but as the latter is so much more favourable to leadership and keeping the men in hand, it should as a rule be employed for this kind of fire; besides, the difference in efficacy is likely to disappear under the more unfavourable conditions of war. How query (*c*) has been dealt with, will be seen in Chapter XV. As far as actual effect is concerned, the results of the experiments have been given in Table XIV., on p. 170, which results, taking the minimum percentages (as should be done), and considering no percentage under 10 per cent. (which, according to German and French estimates, would give 1 per cent. in war*), certainly do not show a sufficiently useful percentage to justify the use of long range fire (*i.e.*, any fire at over 800 yards, as is the usual accepted definition of it) against a line of standing men at over 1,000 yards.

From these facts it may be safely concluded that *the probable result of long range fire is worth the expenditure of ammunition, if there is an ample supply of ammunition for the shorter ranges as well, if it can be easily replenished, if the ranges are known, if the atmospheric conditions† and slopes of the ground are not too unfavourable, if the object fired at is of suitable dimensions, especially as regards depth, and, as we shall see presently, if the fire is executed by troops specially detailed for the purpose.*

Modern regulations for musketry fire have all made certain concessions, such as may have been considered judicious, to long range fire, but at the same time most of them have sought to put officers on their guard against any abuse of it, which might compromise, in any way, the character of energy of movement and efficacy of fire which is the essence of infantry fighting.

Long range fire ought only to be opened on the order of the officers.‡ Its abuse would constitute a grave danger.

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* If each soldier has 100 rounds on entering the combat, and in firing them all away makes one hit only, a body of men, firing, will put out of action a number of men equal in numbers to themselves.

† Such as a strong wind, which deflects the bullet and shakes the rifle.

‡ Really, of the senior officer present.

Employed without discernment it would almost always be inefficacious, which would discourage the troops and raise the *moral* of the enemy, while, also, in spite of all precautions to ensure its replenishment, the ammunition might run out. The 'direction' of long range fire presents serious difficulties, and its efficacy is not in any way comparable to that of shorter ranges. In opening fire at 1,700 yards, a far greater number of cartridges is expended than if the fire were begun at 440 yards, and we run the risk of wanting ammunition at the decisive moment, because the replenishing of the ammunition can never be assured in a certain manner."

Thus, *long range firing must be under the immediate control and supervision of the leaders*, in order to attain its utmost effect, and to prevent waste of ammunition; the men should never be allowed to fire when they like, at what they like, or as many cartridges as they like. But if the senior officer present sees that an opportunity occurs of employing long range fire with success, it would surely be wrong to say that under no circumstances is it to be permitted.

What is waste of ammunition? Is every bullet that does not hit a man wasted? If so, then a vast proportion of bullets fired in any action, even at short ranges, is thrown away.* In reality, the employment of long range fire only ceases to be judicious when the number of hits does not bear a proper proportion to the number of cartridges expended. The proportion accepted abroad is 1 per cent. in war, or 10 per cent. in peace experiments. Admitting this, then, from what has been said, long range firing is admissible when the conditions laid down on p. 257 are fulfilled, and the requisite proportion of hits can be obtained.

2. The second and third objections to the employment of long range fire, apply less to the defensive than the offensive.

* *La Nature*, for February, 1885, publishes some interesting details as to the number of bullets required to kill a man. At Solferino, it is estimated that 8,400,000 shots were fired by the Austrians, which occasioned a loss to the French and Sardinian troops of 2,000 killed and 10,000 wounded, so that in this battle 4,200 shots were required to kill, and 700 to wound one man, showing an expenditure of 278 lbs. of lead for each man killed. The Germans, however, in the Franco-German war appear to have shot much better, for it is calculated that with an expenditure of thirty million rifle bullets and 362,000 artillery projectiles, the French lost 35,000 killed, or died from wounds, thus reducing the average number of shots required to kill a man to 1,300 (about 86 lbs.) This calculation must have been arrived at by assessing the artillery projectiles fired at the number of bullets they would correspond with in weight.

With reference to the second objection to long range fire—the expenditure of ammunition it entails—*as regards the defence*, it will be rarely possible to have (if power of movement in the field is to be retained) such a supply of ammunition as the Turks had at Plevna (500 rounds per man), unless defending an entrenched camp covering an arsenal or depôt of ammunition, and as long range fire has never yet prevented a determined enemy from advancing to close quarters, even though it has inflicted serious losses on him, it would be fatal for the defence to run short of ammunition so as to cripple its action during or after the battle by depriving it of all power of further action until a fresh supply is obtained. Therefore, the employment of long range fire by the defence, will be influenced, not by the range of the rifle, but by whether the expenditure of ammunition will be justified by the losses expected to be inflicted, which in turn depends on the nature of the ground, the quantity of ammunition available, the facility for replenishing it, the formations of the enemy, the accuracy with which the ranges are known, &c. There is further, a moral danger to be considered, namely, that if the defenders do not see the enemy checked at all by their long range fire, they may become demoralized as the enemy approaches. Hence, if a long range fire seems to be having no effect, it should be stopped, and the enemy allowed to approach before opening fire again. But to be able to stop such a fire at will, it must be under the strictest control from the first.

With reference to the attack, in considering the duties of the troops kept in reserve, the difficulties of supplying troops under fire with ammunition (see Chapter XIII.), and that the further the enemy is off, the easier is the supply brought up to the men, the second objection is met, *if the use of long range fire is confined, when the conditions for its employment are favourable, to special troops detailed for the purpose*, to assist the artillery in its preparation, and if it is not executed by the actual assaulting troops. When the actual assault has begun, after a suitable artillery and infantry fire preparation, it should, to ensure the greatest chance of success, be carried out with the greatest energy and in the shortest time possible.

Within the effective range of infantry fire, the attackers, during their advance, must alternately advance rapidly, to avoid loss, and lie down, under cover if possible, to fire and regain breath. Though breathless haste may avoid loss for a time, yet a steady fire alone can inflict it,—but speed of

movement and steadiness of aim cannot go together. To attempt to combine both, in the actual assault, is to sacrifice both, and, as both are requisite, they may be used separately by assigning distinct troops for each—some to prepare and cover the advance, and some to reach the ultimate goal in conjunction with the former.

In addition to the exhaustion of the men during the advance to the assault, which produces unsteadiness of fire, we must consider the exhaustion of ammunition and the means of replenishing it. It is generally accepted that it is impossible for the ammunition with which the infantry is at present supplied (about 100 rounds per man), to last out, if the attacking troops themselves do all the firing, and thus, for the assailant to make full use of his rifle, he should supplement the preparatory artillery fire with long range infantry fire, executed by a certain portion of troops thrown out in advance,* and who could be depended on to hold their ground, and to ply the enemy with an effective fire, until the lines of troops destined to carry out the actual attack move up, and advance to decide the action.

What the attack requires is a preponderance of counter-fire so as not to be over-mastered by the defence, and it is most fully assured by the above method. A deliberate fire from such advanced troops at ranges from 1,300 to 600 yards † behind natural or hastily thrown up cover, ‡ will greatly assist the artillery in its preliminary task of subduing the fire of the defence, and at these ranges a stationary infantry fire may be kept supplied with fresh ammunition by carriers. When their fire is about to be masked by the advance of the attacking troops, they should advance with them. After this combined long range infantry and artillery fire, and still under long range artillery fire (for, except under very favourable circumstances, infantry cannot fire over the heads of friendly troops in

* These may be the advance guard, reinforced, if necessary, by some of the first troops of the main body that arrive.

† The nearer the better for efficacy of fire, but not so close as to prevent their being withdrawn if necessary, or being supplied with fresh ammunition when required, or as to entice or cause the men to bring on a decisive crisis, which may cause them to recoil, lose *moral*, and even draw into the fight the troops in rear, before the way for their action has been properly prepared.

‡ All infantry should carry entrenching tools as part of their equipment (see Chapter XVIII.), and be taught to throw up shelter trenches while lying on the ground.

advance, from the flatness of the rifle trajectories and the danger of stray shots), the assaulting lines will advance as rapidly as possible, and reserve the mass of their fire until within effective ranges, when it becomes too difficult a matter to supply them with fresh ammunition.

This question of how to bring up supplies of ammunition into the firing line during an attack, and how to distribute them to the men actually engaged, is admittedly one of the most difficult, and at the same time one of the most important problems to be solved in modern warfare, and Chapter XIII. is specially devoted to its consideration both for the attack and defence. The matter will be found to be principally a question of administrative detail.

However, the Russians say that modern experience shows that before being sent forward to the attack, every soldier should have at least 120 rounds in his possession, so as to reduce the chance of running short of ammunition to a minimum. There is no doubt that however brave and devoted troops may be, their courage fails them as their ammunition, or power of offence, becomes exhausted.

3. The third objection to the employment of long range fire, that it tends to destroy the offensive spirit—the true secret of success in war—is essentially applicable to the assailing troops. This objection being based on moral grounds, it is difficult to prove or disprove it. The opponents of long range fire say that if men are allowed to open fire at long ranges, they will not advance, but will prefer to lie quietly where they are, and fire away at what they think a safe distance from the enemy. On the other hand it may be urged that such would only be the case with undisciplined troops who are not in hand as they should be. Besides, if men find their fire taking effect, they will willingly go on to complete the defeat of the enemy, and if it is not taking effect it can be stopped, and the men ordered to advance at once, as a corrective.

As a practical fact, it has been found in all wars that when advancing troops begin to feel the fire of the enemy, it is impossible to stop their replying to it,* and hence it will be advantageous to meet this feeling half way, and allow a few rounds to be fired, more for the purpose of keeping up the spirits of the men than for any real effect to be expected from

* A good example of this is given at p. 10 of the *Frontal Attack of Infantry*, but see the first footnote on p. 247.

it, but under the strictest control, during the advance to the more effective ranges, at which a more general and continuous fire will be opened. In the Franco-German war, the Germans suffered much at long ranges when they did not fire, but as soon as they opened fire on the enemy their losses began to decrease, because their bullets began to excite the French troops who no longer adjusted their sights to the range, or aimed with sufficient calmness. The Russians found exactly the same thing in 1877-78.

This third objection, however, can also be met, as was the second, by *only allowing special troops to make use of long range fire* to assist the preparatory artillery fire, and by not allowing the troops who are to carry out the final offensive movement to participate in it.

However, it may be said that the third objection will only be felt when the "fire discipline" (see Chapter XV.) of the troops is imperfect, or when the officers and men have not been sufficiently practised in the use and object of long range fire.

4. The fourth objection that large objects such as battalion columns, &c. (on the losses of which, from long range fire, its advocates lay so much stress), will no more be found on the battle field, may be admitted up to a certain point, but practical experience and experiment, both show that smaller objects such as company columns and thick shooting lines also suffer considerably from fire at very considerable ranges. Further, we must remember that faults will always be committed on the battle field, as history shows.* At any rate every one must admit that the long range fire of infantry will considerably affect the *rôles* of artillery and cavalry, for neither can avoid offering a large target to the enemy. Cavalry can do nothing till it closes with the enemy, and it can now suffer from rifle fire at a distance of 1,400 yards. At 1,400 yards (the extreme sight of the Martini-Henry rifle) 50 men, *if the exact range were known*, could by successively concentrating their fire on the guns of a battery, *employed elsewhere*, very quickly reduce it to silence.

The words "employed elsewhere" are expressly used, as more rifles are required to silence a battery firing on them, than if the battery is firing on another objective. The

* "It is the general who commits the fewest faults and who knows how to profit by those of the enemy, that will obtain the victory." Again, "The best general is he who makes the fewest mistakes."

power of artillery is increasing every day in a far more rapid manner than that of the rifle. Artillery have powerful means of estimating ranges either by watching the large volume of smoke caused by the bursting of shells, or by means of the accurate range-finders they can safely employ. Artillery fire, again, is vastly superior as regards accuracy than musketry fire, and each shrapnel shell of the 9-pounder gun carries 63 bullets, which at 1,400 yards, spread over a considerable area, especially in depth, the density of the hits on which would be increased in the same ratio as the number of guns firing on the same object. The new 13-pounder gun has a shrapnel shell which carries 116 bullets, and its fire will be all the more terrible and accurate than that of a 9-pounder gun, from its greater number of bullets, its greater striking velocity, and its flatter trajectory. Infantry have not the means of judging the range with anything like the same accuracy, and the accuracy of its fire decreases very rapidly as compared with that of artillery, as the range increases.

5. With regard to the fifth objection to the employment of long range fire, that the combined use of several sights is not conducive to efficacy of fire, we cannot from any war experience say definitely whether it is or is not expedient to fire at the same object with different sights; but peace experiments have shewn that a better useful effect can be obtained from them, than with a single sight, when the object fired at is very deep, when it is moving, and when the range is imperfectly known, *under which conditions only it is proposed to employ them.* The bullet rain caused by a combined use of different sights, is more evenly spread over a given surface, and the zone of useful effect is considerably deepened, but on the other hand, with a given number of men firing, according as 2 or 3 sights are employed, within each half or third, respectively, of that zone, only one-half or one-third of the number of bullets fall that would take effect if only one sight were used. Therefore, if a long range fire is to be opened, it is not judicious to employ a combination of sights, except under the specific conditions laid down, which enable a *more certain* useful effect to be obtained in such cases, than when a single sight is used.

6. The sixth objection that a long range fire will reduce the efficacy of the fire at shorter ranges, has more real value than at first sight appears, as it depends a great deal on the physical nature of the man. There is no doubt that the use of long range fire greatly increases the number

of rounds fired, and the more rounds fired the greater is the fatigue caused to the men, and the less efficacious will be the fire. Again, the effect of the recoil of the rifle soon begins to tell most seriously, and after some rounds the shoulder gets so sore that the men fear to put the rifle to it. This especially applies to our Martini-Henry rifle.* This may account for the French and Turks, in the wars of 1870 and 1877, who made use of long range fire, having fired so much from the hips, and consequently as the enemy got nearer, the fire was found to be less efficacious.† No fire discipline will get over this difficulty, which is a most serious one. The recoil of the Martini-Henry rifle is the greatest of all the European rifles, and is its greatest defect. This evil is greatly reduced in our future rifle.

This objection can be best overcome by *the employment of different troops for long range fire and for the attack*, as already suggested.

It cannot be too strongly laid down that *the general question as to the advisability of employing long range fire is intimately bound up with that of the available supply of ammunition, the facility for replenishing it, and with the means available for ascertaining the ranges*. At long ranges, the efficacy of the fire, falling more or less vertically over the beaten zone, becomes very small, and hence if the greatest effect is to be produced, the range must be accurately determined within 50 yards, or half the constant beaten zone of a collective fire. But the more accurately the range is determined the better will the densest part of the nucleus be brought on to the objective, and the more effective will be the fire.

Thus, the objections to the employment of long range fire fail so long as *it is employed by special troops, is kept well under control, and is only resorted to when the result is likely to justify the expenditure of ammunition*. This latter consideration will be greatly influenced by the size of the objectives, the probable accuracy with which the range is known, atmospheric conditions, the slopes of the ground, and by the supply of ammunition available at the particular time and place, and the facility for replenishing it, and hence the decision must be made by *the responsible senior officer present*, who alone can judge of this.

* See footnote, p. 21.

† That is to say when the attackers fired while advancing. When the Russians did not fire and so intimidate their opponents, they suffered more as they got nearer.

If the ground in front of a position to be defended, slopes sufficiently, and the defenders can have two or more lines one above the other so as to form a series of lines of fire, the rear lines will be able to fire with safety over the heads of the men in front, and keep up a very effective fire against the supports and reserves of the attack, while the men in the front line engage the enemy's skirmishers or check their advance. But such a fire will only be feasible at the longer ranges while the enemy is still at some distance (because of the low trajectories of the bullets at the shorter ranges), and with troops having a "fire discipline." In the defence of such a position, long range fire will prove of the greatest advantage, if the supply of ammunition available justifies the expenditure, as, by its employment, and in no other way, can losses be inflicted with certainty simultaneously on all the lines (firing, supports, and reserves) of an attacking force.*

On the offensive, if attacking troops suffer much from a long range fire of the defenders, it is desirable, in order to give a moral support to the men, that they should be occasionally allowed, during their advance, to answer it, because advancing without firing in such a case is very demoralising to the men. But this should only be done with the greatest circumspection, and in no case must it ever endanger the ammunition running short before the final assault. Further, as has been already stated, a well-directed fire kept up by the attack demoralizes the defenders, and causes the attacking troops to suffer less as they get nearer the enemy.

Thus the employment of long range fire, *under suitable conditions*, being permissible, the next thing to consider is—what do we mean by a long range fire? At what minimum distance may it be said to commence? What is its character? The Germans, who must be considered as the great masters in the art of war, consider that fire at very long ranges should be left exclusively to the artillery—infantry fire being employed only at the shorter ranges. "Short range for infantry, long range for artillery,—that is briefly the division of the parts which, they consider, the two arms are specially called upon to play on the field of battle. But where are we to draw the line between long and short ranges?"

See footnote, p. 222.

The Germans divide the space in front of a line of infantry into three zones, viz. :—

The short zone from the muzzle up to 440 yards.

The medium zone from 440 yards to 770 yards.

The long zone from 770 yards up to 1,300 yards.

The French divide the ground in front of a line of infantry in a similar manner, thus :—

The short distances, from 0 to 440 yards.

The medium distances, from 440 yards to 880 yards.

The long distances, from 880 yards to 1,650 yards.

The extreme distances, beyond 1,650 yards.

This is the sub-division that has been practically adopted in our "Field Exercises for Infantry, 1884" (page 305), but the compilers of this drill book, in laying down 1,700 yards, as they have done, for the extreme limit of long range rifle fire, appear to have forgotten that the Martini-Henry rifle is only sighted to 1,400 yards, and that therefore we cannot fire up to 1,700 yards with it, although the French rifle is sighted to this distance.

The Austrian sub-division is :—

The short zone, from 0 to 500 paces (417 yards).

The medium zone, from 500 to 1,000 paces (417 to 835 yards).

The long zone, from 1,000 to 2,000 paces (835 to 1,670 yards).

From what we have said in Part I., and in Chapter IX., and from the construction of the sights of the Martini-Henry rifle, we may accept for our own practice, the sub-division of the ground into the following zones* :—

The short zone, from 0 to 400 yards.

The medium zone, from 400 yards to 800 yards.

The long zone, from 800 to 1,400 yards.

The sight for 400 yards is the greatest elevation given by the bed of the back sight, and 1,400 yards is the extreme elevation of the rifle, which is a little over the German estimate, but under that of the French and Austrian.

Although they differ as above in dividing up the ground in front of infantry, the French and Germans agree pretty fairly as to the fire tactics to be used in each zone or class of distances.

* This sub-division the Author considers preferable to that given in the drill-book of 1884 The method of sighting will impress the 400 yards range on the memory of the dullest soldier; 800 yards is twice 400 yards, and 1,400 yards is the extreme distance for which the rifle is sighted. This sub-division has lately been practically adopted officially.

The short zone, they consider, belongs exclusively to independent firing; it is for the free independent fire of troops, each man choosing his own mark, as at these ranges it is not necessary, from the accuracy of the arm, to direct several rifles the same object to gain an effect. At these short ranges this independent fire becomes very rapid. Rapid independent fire entails the largest expenditure of ammunition, during the time it lasts, makes the men unsteady, and, if the line is stationary, soon renders all aiming impossible from the men being enveloped in a thick cloud of smoke after a few rounds. This sort of fire is, therefore, only to be used exceptionally, and very sparingly, and only within the short zone.

Beyond 400 yards nothing is to be expected in action from single shots, as at such distances any skill of shooting and quality of the rifle cannot counterbalance the unfavourable moral influences of a combat, and of not being sufficiently certain of the range, both of which are independent of a man's personal skill. The fire of single men beyond this range the Germans consider to be a veritable waste of ammunition, because the dangerous zones of the rifle at these ranges are not sufficiently large to compensate the effects of error in judging distances. The soldier having reached the short zone may be left free to choose his own object, because it is no longer necessary, in order to obtain a result, to direct the fire of several rifles at once on the same object, for the errors to be expected in judging distance are here proportional to the extent of the dangerous zones, and the size of the areas representing the grouping of the shots at these ranges do not exceed that of the breast of a horse; nor do they equal the front of two men, even at 400 yards. (See Table of Errors, p. 53.)

Objects in *the medium zone* should be covered with a carefully concentrated fire of groups of men in extended order on the same object, and under the orders of their officers.

The zone of medium ranges is specially appropriated for the collective fire of groups, by which is meant the fire of groups of skirmishers directed on the same object (in which it differs from the independent fire of skirmishers), and it may be directed on any objects, no matter what their dimensions are.

In the *zone of long ranges*, the Germans deprecate any general use of even concentrated fire, but when used, they say it should be chiefly directed on objects having a certain amount of breadth and depth, such as a battery, a close

infantry column of at least 200 men, or a squadron column of cavalry.

In any such case a concentrated fire is to be directed on it by the largest available tactical units, so as to attain the desired result as quickly as possible.

Over 1,300 yards or in *the extreme ranges*, as they may be called, we come to the zone of field artillery fire, which extends up to about 3,500 yards, and the Germans consider that the fire action must be then left in the hands of the artillery, because the ranges beyond 1,300 yards cannot be judged sufficiently accurately, and the fire is so uncertain as not to be worth the expenditure of cartridges. In fact, the Germans and other nations ridicule the idea of expecting an efficacious infantry fire at a greater range than about 1,300 yards. Thus infantry, at least in the open field should not be called on to fire beyond the limits of the long zone, but should leave to its better qualified auxiliary, the duty of preparing the task which it will be the duty of the infantry to complete when the proper time comes.

The Russians, whose close formations suffered so terribly in 1877-78 from the long range fire of the Turkish infantry—but which did not stop their advancing—say in their latest regulations, that the accuracy of the rifle only shows itself fully when the dimensions of the object aimed at are in keeping with the range; that *as close fire alone has any real accuracy and importance in battle, the long range power of the rifle must be used with extreme reserve, and then only when the result is pretty sure to justify the expenditure of ammunition*; two or more sights will be used in long range fire; over 500 yards only one sight will be exceptionally used; individual fire is effective up to 750 yards, but beyond this any effect is only due to chance, and therefore at longer ranges the fire of groups must be used so as to concentrate a number of shots upon special points; the concentration of fire is equally effective at shorter ranges; skirmishers are never to fire when on the move, as it would render their fire completely ineffective; they may fire either individually or by fractions, if the object aimed at is in keeping with the distance.

A French writer, M. Emile Simond, says, "It is fire *alone* which will assure victory in the future to the troops who know how to make use of it. Not only will long range fire prepare the attack, but short range fire will often prove useless, and the issue of the battle will have been decided before the enemy is approached. . . . . . The war of

1870-71 not only demonstrated the already-known necessity for a preponderance of fire, but it showed at the same time the power both of long range and of rapid firing.* The success of the Prussians has been attributed to many causes which have nothing to do with it; particularly the famous principle of sparing the ammunition, and of only opening fire at short ranges. In fact, while the French caused a rain of projectiles at considerable distances, the Prussians reserved their fire for the distance of 400 paces. At long distances the French bullets, generally fired anyhow, on account of the bad instruction the French soldiers had received in musketry, covered the ground uniformly, and caused considerable losses to the German reserves. Unfortunately, once this zone was crossed, the enemy was not much exposed, because the short range fire, though rapid, was not adjusted; as a consequence, it only quickened the advance of the enemy, who sought to escape the bullets of the French, whose inefficacious fire could neither stop nor destroy them. At short ranges, the French soldiers always fired too high. In the infatuation which arose for the German army, their fire tactics were much praised, and the French long range fire was blamed. This reproach is not just, since the French inflicted the most serious losses on their enemies with this kind of fire. Only the faulty execution of their short range fire should be blamed. The Germans have not been blind to this question, and, immediately after the war, they studied both long range and rapid firing. Why economise cartridges when good results can be obtained? If the French made an error, it was in not having sufficiently studied the methods of firing, and in not having ensured the replenishment of the ammunition. We have only to recall the manner in which the French inflicted losses on the Germans in 1870. It must not be forgotten that, although overwhelmed by numbers, the French almost always, in the battles previous to Sedan, inflicted greater losses on the Germans, than the latter did on them."

M. Simond also seeks to prove the same point from the Russo-Turkish war, viz., the greater value of a long range and rapid fire over short range firing; and in support of his opinion he quotes the Russian General Zeddeler, as follows:—"Our (the Russian) regulations were not in accordance with the requirements of modern fighting, for they particularly insisted on the necessity

* It is not merely rapid, but accurate fire that is required.

of economising cartridges, and on accuracy of fire. This principle of economy of ammunition was what we had most at heart, and we did not cease to recommend it to the men. When the Turks gave their infantry a long-range and rapid-loading weapon, they were not deluded with the illusion that their troops would only fire at short ranges and would spare their ammunition. They viewed the situation much more simply, and decided to utilize to the utmost limits the properties of the rifle, and to fire on all objectives with the greatest rapidity possible. If we compare the Turkish army with the French army in 1870, we see an identical employment of the rapid-loading rifle, the only difference being that the Turks obtained results which the French had not thought of. . . . . Now-a-days extended order has been adopted, and the only favourable objectives that show themselves are the firing line and its supports when they change position at the double, that is to say, when they make short appearances. It would not be reasonable, with such targets, to fire little and at short ranges. Two recent campaigns, made with the new armament, show that long range fire, even when very imperfect and badly studied, can, nevertheless, produce considerable effects. Besides, waste of ammunition and bad employment of fire in past wars, do not prove anything against rapid firing and its employment at long ranges, but rather a defective application in the methods of using it, and lastly, when the control of the fire has escaped from the leader, the fault lay, in most cases, in the insufficiency of the regulations as regards rules for firing. Consequently, it is necessary to practise all infantry in long range fire, as a procedure in war. *It is necessary to overwhelm rapidly, by the aid of masses of lead instantaneously projected, the unfavourable objects which now-a-days show themselves on the battle field.* It is not sufficient to content oneself with firing little and accurately, but to try and avoid all defective employment of fire, by determining beforehand the different cases in which one or the other method of firing ought to be used."

M. Simond continues, "Colonel P——, said in 1880, that 'the material effects of a fire at 200 mètres are absolutely *nil*, if the ground is not horizontal. Further, the cases are rare when fire at 100 mètres will have any efficacy; to obtain this, it is necessary to fire on a plateau at a level of at least 10 mètres higher. For this reason, it is always necessary to fire at a longer range. Therefore, it is generally from a distance that an efficacious fire will ensure the success that will take

place.' . . . . Colonel P—— bases his theory on the effect of fire on different slopes of ground, but it can also be justified by numerous examples drawn from late wars, and especially from the Russo-Turkish war. The Turks, notwithstanding the advantages of their entrenched position before Plevna, always fled when the Russians came within 300 mètres of them.* It was at the long distances, on the other hand, that the fire of the Turks was deadly, and occasioned terrible losses on the Russians. Captain Kouropatkin has said on this subject: 'The fire from an entrenched position does not increase in intensity according as the assailant advances; it appears that the precision of the fire is greatest at from 1,200 to 600 paces, after which it gets less. The least courageous men cease firing; most of the others load and pull the trigger without raising it to the shoulder, and hence the mass of the bullets fly over the heads of the adversary.'

"When the assailant has arrived within a short distance, the *moral* of the defenders is shaken, the emotion of the fight is at its greatest intensity, any want of skill among the men influences, not only the accuracy, but also the rapidity of the fire, which at this moment, therefore, becomes less rapid and deadly. The Prussians understood this well in 1870, as they rushed to the assault as soon as possible, because, as the Prussian General Paris says, 'once the long range zone had been crossed, the men were little exposed, from the bullets passing too high.' In the Russo-Turkish war, the Russian reserves, in spite of their officers, threw themselves into the firing line, because they were suffering more losses than the latter without being able to reply, and because they wished to advance more rapidly. The attacks degenerated into regular races, the assailant seeking to suffer less losses by approaching the position. Thus, a rapid fire at short ranges is not the decisive fire."

The conclusion here arrived at is open to much criticism. In the first place, the long range fire of the French and Turks, although it caused losses to their opponents, never stopped their attacks altogether, and so never produced a decisive effect. The severe losses at long ranges which the Germans and Russians suffered in their attacks were due more to their premature attacks, before a sufficient preparation had been effected by their artillery, and to the favourable objectives they presented to the fire of their enemy by their dense

* This statement, as a fixed rule, is hardly in accordance with the different accounts of the war.

formations, than to the mere fact that their opponents fired at long ranges, and although the Germans and Russians suffered more total losses than their opponents, yet at the shorter ranges they did such execution in so short a time as to demoralize the enemy sufficiently to admit of an advance in mass to capture the position. The result of a battle does not depend on the number killed and wounded, but on the determination or obstinacy of the troops to stand or advance, and *this determination is best overcome, not by the total number of losses, irrespective of the time they are inflicted in, but on the rapidity with which the losses are effected.* The French and Turks aimed at the centre of the enemy's bodies, and as at close ranges they did not alter their sights, the fire in any case would have gone over the enemy's head, especially as they were firing downhill (see p. 160). It was only when the Germans and Russians began to open fire and to so discompose their enemies as to prevent them adjusting their sights or aiming, that their losses began to decrease; but these losses were principally due to the faulty tactics and faulty attack formations employed when the losses were incurred, and which exposed closed masses of troops to the enemy's fire. What the effects of fire will be in the future when opposed to modern ideas of attack formations and methods of using fire can only be decided by the next great campaign, but M. Simond's arguments, given above, can only go to prove that the defence may open fire *on suitable objectives* at longer ranges than the offensive, from the ranges being known and the means of supplying ammunition being more easily carried out.

French, Germans, Russians, all say that on account of *the great efficacy of short range fire, which alone is decisive*, and from the uncertainty of estimating ranges and of being able to replenish the ammunition expended, the attack will always endeavour to get within the short or effective ranges of the enemy before opening fire.

"Nevertheless, the most determined advocates of this close fire allow that the troops of the first line can only fulfil the requirement of getting within effective range of the enemy when the ground on which they move is particularly favourable. Should it not be so, fire must be opened before arriving at 400 yards, that is to say, at some distance between 800 and 400 yards.

"In the German army it is held that, when on the defensive, fire should be opened sooner than on the offensive, as a rule at 800 yards. This divergence of practice is justified by

the facts that, for the defensive, the ranges are more accurately known and may even be marked, the supply of ammunition is easier, the troops are under cover, and can fire from a rest.

"It is needless to say that, if before arriving at 800 yards distance, the enemy should offer a favourable mark, a fire of masses would be directed upon it."

The French and Germans fix the limits of individual fire at 440 yards, the Austrians at 550 yards, the Russians at 750 yards. The Germans, as we have seen, say that beyond 440 yards, the rifle is only really effective on larger targets than the surface of a single man when the range has to be estimated by eye and therefore beyond that range it becomes necessary to employ a concentration of fire. Even single marksmen are not allowed to fire at guessed ranges beyond 440 yards, but if the range is known then they may fire up to 770 yards, but not beyond. It is probable that the Russian limit of 750 yards is the theoretical limit, and either supposes an exact knowledge of the range, or that thick lines of skirmishers are being fired at.

The extreme limit of long range fire is that distance at which the effect of concentration of fire becomes insignificant, even under favourable circumstances, such as when employed against objects with the width and depth of a company column of 200 men, a squadron, or a battery of artillery, the ranges being fairly known, and the atmospheric conditions not very unfavourable. Experiments on level ground and measured ranges show this limit to be that of the extreme range of the rifle, 3,400 yards, but in war on varied ground, with unmeasured ranges, and perhaps with smoke obstructing the view, this distance the Germans consider must be reduced to 1,300 yards as a maximum, while the French put it at 1,650 yards.

Thus we see that from 1,300 to 1,600 yards may be considered as the extreme range of concentrated infantry fire, and then only at well marked objects.

From the difficulty experienced in obtaining the range, and the uncertainty of being able to test it by watching the strike of the bullets, the use of several sights was instituted so as to sweep a greater zone with fire, but even then very little effect may be produced, because the experiments we have referred to, show that even a concentrated fire from a large number of rifles between 1,100 and 1,300 yards over measured ranges, has practically no effect against troops *in line*, and only a slight one against small company *columns* (of 200 men) which ceases altogether at about 1,500 yards.

Over this range, the lateral scattering of the bullets increases so sensibly that the ground can no longer be properly swept without an enormous consumption of ammunition. But of course if very large objects appear, as whole battalions in columns, and cavalry and artillery in masses, which however will be rarely the case, as it would show great laxity on the part of the enemy, then fire may be opened at ranges over 1,300 yards,* but as over this range the strike cannot be seen, and the efficacy of ricocheting bullets is greatly lessened, the effect of the fire is likely to be so much diminished that we may say that under ordinary circumstances the extreme range of infantry fire is 1,300 yards.

With regard to firing at bodies with a small front, as columns, at ranges over 1,300 yards, even a light wind causes a considerable deflection of the bullets (see p. 39), and as the amount of this deflection can only be detected by seeing the strike of the bullets, we may consider as a general rule that *long range fire cannot be depended on in the field when the strike of the bullets* cannot be observed, which is at the most, under favourable circumstances, about 1,300 yards, and it must be ever borne in mind that an ineffective fire weakens the moral force of the troops using it, when they see no result from it, while it raises that of the adversary and encourages him.

Therefore, *in the field*, the extreme limit of long range fire may be fixed at 1,300 yards, and then only when employed against an object of sufficient dimensions, such as a column of 200 men, a squadron, or a battery of artillery, when the available supply of ammunition on the spot justifies the expenditure, when the atmospheric conditions and slopes of the ground are not unfavourable, and when the ranges are known within sufficient limits, but it is only at ranges under 1,000 yards that any real serious results need be expected, as troops under fire will invariably be in an extended line.

"The power and efficacy of modern fire depends on two conditions: firstly, on the exact appreciation of the distance, which, on the other hand, is strictly connected with the flatness of the trajectory; and secondly, on the formation of the troops fired on."

The Germans have no great partiality for fire over 1,300 yards, nor for indirect fire in field operations. This

* With the English rifle we cannot fire over 1,400 yards in the field, without special arrangements for doing so. From what has been said, this is rather an advantage than otherwise.

is what a German writer says:—"Is it not a characteristic sign that it is in the small armies of Europe that advocates are found for settling the question of long range infantry fire according to the results of the practice range, whilst in the great armies it is settled on very different principles? Is it thus reserved for those who have had no opportunity of gaining war experience, and can have, therefore, but a limited scope of view, to bring out theories and to push speculation to its extreme limit?"

The main firing line of the defence should not carry on a long range fire, but this should be done by advanced troops or outposts, or guns supported by an escort of infantry sent forward to compel the infantry of the enemy to deploy sooner.* These troops would, of course, have to withdraw when attacked by superior forces, probably when the enemy arrives within about 600 yards of them, so as not to retreat† under a heavy fire, and with great loss. Thus the troops who have to carry on the main defence are left intact when the enemy approaches, and will have a full supply of ammunition which, therefore, may not require replenishing during the heat of the action, while some of that of the enemy has already been expended. Thus on the defensive, long range fire will be principally used at the commencement of the action, and its use restricted to fortified advanced posts, and to detachments whose object will be obtained if they compel the assailant prematurely to assume an open formation.

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* The advantage of forcing an early deployment on the part of the enemy, instead of letting him approach to closer ranges in denser formations, is that at the commencement of an engagement the attackers are uncertain of the defensive arrangements, and this forced early deployment prevents any mistake in the disposition of the attack being corrected, as troops extended under fire cannot manœuvre, but only move straight to the front or rear. Moreover, from the difficulty of controlling extended troops, the advance is made slower, and confusion is more quickly caused, by the inevitable mixture of troops which takes place when supports, &c., are sent forward to reinforce the firing line. This early deployment may also cause the enemy to open fire sooner than he should, and so cause him to use up his ammunition, while it renders the control of his fire more difficult. "It is inconvenient for the attack to deploy at a great distance from the enemy; it is a reason for the defence to try and compel it to do so." This is one great reason for occupying advanced posts in front of a defensive position.

† It is advisable that any small detachments, other than those placed in advanced posts, sent forward by the defence to compel the enemy to assume open formations prematurely, should be taken from the reserve and return to it after retreating.

Expenditure of ammunition need not be considered in such a case by these advanced detachments.

The Dutch regulations say:—"Firing at long distances has for its object to prolong the preparation and to compel the adversary to assume early a more open formation and to seek for shelter. But as the result of any battle is decided at short ranges, sufficient ammunition must always be maintained for the close fight, and all useless expenditure of ammunition must be avoided."

The employment of long range fire by *the attack* has already been discussed, namely, that it should not be used by infantry destined to execute the actual assault, but by lines of infantry judiciously posted so as to facilitate by their fire the advance of the former.

In the attack of stationary objects, like fieldworks, fortifications, entrenchments, camps, &c., long range fire over 1,300 yards may be extremely useful. In the open field the rifles can only be fired from the shoulder, but in the above cases, the rifles may be fired from rests, causing a far more accurate fire, a concentrated fire may in such cases be used up to ranges of 3,000 yards, as every accurate means can then be used for obtaining the exact range, and the supply of ammunition will be practically unlimited.

"It must not be forgotten that long range fire only offers grave inconveniences, without any advantage, to an army which attempts to make use of it in the field without previous practice. The use of long range fire is too delicate to allow of its being thus improvised. It is only by means of well-studied and understood regulations, and by constant experiments and practice, that troops can be made to execute it with coolness, and the officers to direct it with discernment."

Whatever uses long range fire may be put to, the fact must never be lost sight of, that in an attack, if the fire be commenced too soon, the offensive spirit of the troops will suffer and will give the attack a prolonged character. Further, the moral force of troops will suffer as soon as they perceive their own fire to be ineffective, while that of the adversaries increases in power.

The great point, however, that must always be clearly kept in mind is that *long range fire can never replace the decisive fire at short ranges*; long range fire can only play a secondary part, never a decisive one, but this secondary *rôle* may, in many instances, be of the greatest value if used judiciously and under the conditions already stated.

Every nation has laid down, in a more or less detailed manner, the fire tactics to be carried out in an action, even though they do not agree in every point. Some think that infantry fire will be useful in the preparation of the fight, and are disposed to begin to open fire at from 1,200 to 1,300 yards, and even beyond; others say that fire should not be opened until within 700 or 800 yards of the enemy, or even nearer. But all are unanimous that the final phase, whether it is ordered or not, will be an intense fire, during which one side or the other will abandon the fight after a short time involuntarily.

However, it is evident that, in the future, two adversaries will enter into a war with the feeling that it will be by fire that they will determine success, either by its quality or quantity, or, better still, by a combination of both the quality and quantity, and that every effort will be made to obtain the maximum effect from the rifle.

Now-a-days, since fire is considered the only means of destruction in battle between two adversaries, the first thing to be considered, after regulating the employment of the fire, is the question of replenishing the ammunition that will be expended.

The consideration of the supply of ammunition and the facility for replenishing it, exercises, as we have seen, a very great influence on the question as to when the order to commence firing should begin. It is certain that a body of troops, having an unlimited supply of ammunition, need not fear any waste of ammunition, nor of its running short at the decisive moment, and can open fire at far greater ranges than those fixed for ordinary circumstances.

Besides, even if it is necessary to increase in strong proportions the supply of ammunition carried by the men, it would not be a serious reason to refuse any rifle or method of firing which will give us a superiority of fire on the battle field. The question of fire is strictly connected with that of the supply and replenishment of the ammunition. But we ought not to subordinate the fire to the number of cartridges carried by the men, that is to say, the principal to the secondary consideration. If the new tactics of the future require a greater number of cartridges, we must seek new expedients for supplying them to the soldier on the battle field. We must not give up any advantage offered by a particular kind of fire, which may decide success because we have only insufficient means for carrying the required quantity of ammunition. Further

on we shall see that it is possible to easily allot more ammunition to the soldier than he has at present at his disposal. "The condition, which ought to overrule all others, is to obtain a superiority of fire. It is necessary that everything should give in to this requirement. This is the price of victory."

The value of preventing the supply of ammunition running short being so great, we will now proceed in the next Chapter to consider how it is effected.

CHAPTER XIII.

SUPPLY OF AMMUNITION ON THE BATTLE FIELD.

The question of the supply of ammunition for infantry and of replenishing this ammunition on the battle field is now-a-days an all important one. Modern rifles of rapid fire and long range have, in fact, introduced into war a new factor, which imposes the absolute obligation of modifying the tactics of fighting, of regulating the employment of the fire, and of keeping up its intensity during the whole duration of a long fight, by means of a well-arranged system of replenishing the ammunition. The wars of 1870-71 and 1877-78 have both shown in an undoubted manner the immense value of a vigorously conducted and well-directed infantry fire, when directed on suitable objectives at the greatest distances, in all periods of the fight, from the preparation of the attack to the pursuit of the enemy. But this can only be attempted when there is sufficient ammunition available. Although entire confidence cannot be put in long range fire, yet where it is possible to use it with effect it should not be neglected, because the material effects so produced always give a moral superiority, which is one of the most solid guarantees of success to the troops who possess it.

With the use of long range fire, we must admit of a greater consumption of cartridges than in the past, and of a greater necessity for ensuring to the infantry a certain and sufficient replenishment of the consumed ammunition, this replenishment being, according to Von Schreff, a condition for the existence of infantry, to which, therefore, a full and entire satisfaction must be given. On the other hand, an increase of the number of cartridges carried by the foot soldier without a corresponding decrease in the weight of the articles of his equipment, is limited by the fatigue which this increase of load would cause him. Therefore, it is equally important to consider the means of improving the methods of supplying the troops in the firing line during the fight, as well as of increasing the supply to be carried by the soldier when he enters into action.

Horsetzky (an Austrian officer) says, "The principal objection against long range fire is *waste of ammunition*. The same objection was raised against breech-loading rifles at the time of their adoption. What is meant by waste of ammunition? Is every bullet which misses its mark to be considered as such? If so, then millions of cartridges fired even at short ranges must be considered wasted, for experience shows that even in the close fight the average efficacy of the fire is less than 1 per cent. In reality, expenditure of ammunition will be judicious as long as the number of shots fired maintain a suitable relation with the results which the ballistic qualities of the rifle, the range, and the dimensions of the object would lead us to expect. Troops who fire at long ranges will evidently have more occasions for making use of their fire, and will, therefore, expend more cartridges than troops who only fire at short ranges. Thus the employment of long range fire compels an increase in the number of cartridges to be put at the disposal of the men. But this is only a secondary point. If long range fire is recognised as a real advantage, this consideration is only a matter of detail, because we must regulate the supply of ammunition to the necessities of the combat, and not make the mode of action of the infantry depend on a number of cartridges fixed on beforehand. The measures to be taken to secure ammunition in sufficient quantities to the troops lie in the domain of organisation, which latter ought to conform itself to the requirements of tactics."

It is useless to try and base our calculations for the amount of ammunition required to be available for a soldier on his entry into action on the experience of past wars, because the conditions of future wars, in which both opponents will be well trained in fire tactics, will not be the same as in the past. Besides it is very hard to obtain even approximately the amount of ammunition expended in various wars. And then, again, the statistics given are often very misleading; the average number of cartridges expended per man of the *whole* force is often given, which average is not usually very great. But it is very rare that the whole force is ever engaged. Generally all the effort of a battle, especially as regards infantry fire, falls on the troops in the fighting line, the remainder of the force acting in a moral sense by its presence on the field and being available for action. Thus, many battalions fire away a great many more rounds per man than the average for the whole force, and in providing ammunition

for troops, the estimate must not be for the *average*, but for the *maximum* expenditure in one day, and also for the possibility of the troops being engaged for several consecutive days without having an opportunity of making up their supply of ammunition.

In the campaign of 1866 the Prussians in both Hanover and Bohemia only expended 1,850,000 cartridges altogether for 268,000 rifles, or about 7 rounds per man, including lost cartridges and those of the wounded, dead and disappeared; but at Koniggratz the I. Prussian Army, heavily engaged all day, only spent on an average 12 rounds per man, though one regiment (three battalions) expended 30 rounds per man, and some companies 80 rounds per man, or 20 rounds more than they carried. At Nachod, one battalion consumed 23 rounds per man, at Skalitz and Trautenau the average expenditure was 28 rounds per man, but some of the leading companies fired away 80 to 100 rounds per man. *This was all short range fire.*

The Austrians, on the other hand, though only armed with muzzle-loaders, expended 64 rounds per rifle in Bohemia, and 5 rounds per rifle in Italy, or 15,600,000 rounds in all, as against one-eighth that number fired away by the Prussian breech-loader. This was a curious and unexpected result, and gave rise to the supposition, that with a rapid-firing rifle the fire would be quicker, but that there would be less of it on account of the decision being more quickly arrived at.

But the war of 1870-71 showed the falseness of this deduction, when the breech-loader was pitted against the breech-loader, for the Germans expended 30,000,000 cartridges.

In 1870 the French Army of Metz, during the three days of the 14th, 16th and 18th August (the last date being that of the battle of Gravelotte), expended 25 to 30 rounds per man, but the troops defending St. Privat fired away all their cartridges (90 rounds per man), and had to retire purely for want of ammunition. *This was a long range fire.* At the action of Champigny, during the Siege of Paris, the French had 108 rounds per man, which were nearly all used up, and the French had to retire. *This result was due to a want of artillery preparation.* The XII. German Corps fired in various battles from 6 to 15 rounds per man, *using short range fire* only, though some of the German troops in the war, when unable to advance, fired away all their ammunition after three or four hours fighting, and had often to draw on their ammunition columns. *When this happened it was due to a want*,

or insufficiency, of artillery preparation. In five German Army Corps the consumption for the whole war was 90 rounds per rifle, and in three others, 45 rounds per rifle. These are only averages for the whole force, and do not represent the expenditure of the corps and units first thrown into action, who often used up their whole supply. It is this expenditure of single units that is of the greatest importance. In the wars of 1866 and 1870-71 this expenditure often amounted to 100 rounds per man, and in the war of 1877-78 to over this number.

At the same time it must be remembered that during this Franco-German war, no real fire tactics, as now understood, existed, and the importance and necessity of collective fire at ranges over 400 yards, so as to obtain the maximum efficacy from the rifle, was not realised, or consequently practised.

The Russians, in 1877-78, fired 50 rounds per man, though, on many occasions, some of the troops fired away all they had, their greatest consumption being 94 rounds per man. Some Turkish battalions fired 150 rounds, and, as some assert, even 500 rounds per man in the day, *using a wild undisciplined long range fire*. This is the highest expenditure ever known.

It must be borne in mind that the above figures are in excess of the real number of cartridges actually fired, for they include ammunition that had not been fired, but which was lost by being dropped or left on the dead and wounded. However, such contingencies must enter into our calculations, as they will always occur.

In some experiments made in Germany in 1876, during a field day in which the heaviest fire was ordered to be kept up, no man fired more than 40 rounds, but *only short range firing was used*. But on the other hand, at some experiments made at Cassel in 1878, in the Grand Manoeuvres of the XI. German Army Corps, where the new principles of infantry fire tactics (already described), *including long range firing*, were carried out, an average of 100 or 120 rounds per man were fired away in exercises which only lasted three or four hours, and during which the fire was conducted with the greatest coolness and economy, and if we allow half more for the increase caused by the consumption and loss due to the excitement of the fight, this will give upwards of 180 rounds per man, while many writers of authority assert that 200 or 250 rounds per man should be available for the troops first thrown into the fight.

The experiments made at the Camp at Chalons in 1878, pointed out that, *where long range fire is to be employed*, each man should have at his disposal *at least* 100 cartridges, *exclusive* of those carried in any battalion wagons, or in the ammunition columns which may be attached to the force.

The Russians are now unanimous in saying that each soldier should have 120 rounds on him, on entry into action, so as to prevent any chance of his running short of ammunition.

In all the above data, and in others that could be quoted, we see that the expenditure is always the greatest for troops who have made use of long range fire, and therefore it behoves any commander to weigh well the question of his supply of ammunition and the means of replenishing it, before he decides on employing such a fire, even if the other considerations, mentioned in the last chapter, do not render such a course unadvisable.

On the defensive,* the means of replenishing ammunition is comparatively easy, as supplies can be brought up close to the troops in the firing line, who are stationary, and distributed to the men before the approach of the enemy. The men can prepare little receptacles to place their ammunition in, so as to facilitate loading.

On the offensive, while the enemy is still at a distance, and long range fire is being employed, and the effect of the enemy's fire is not great, the replenishing of expended ammunition can be carried out without much difficulty, but as the enemy is approached the difficulty of doing this becomes so great, that the German regulations say that the full supply of ammunition must be served out before sending the men forward, and that under fire the cartridges of the killed and wounded are to be utilised.

" On account of the fewer facilities for bringing up ammunition in an attack, men and officers, if well instructed in their duties, will clearly see that owing to the difficulty and even impossibility sometimes of replenishing the ammunition fired away, they ought to make use of their fire so as not to have emptied their pouches before at least having assaulted the position; but the defenders, placed in shelter trenches, behind walls, or other natural or artificial obstacles, know

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* The action of a rear-guard during a retreat is included in the words " On the defensive ; " supply depôts of ammunition can be left at known points on the line of retreat for its use.

that their means of replenishing ammunition is easy and even prepared. The conclusion from this is, that in an action, it is less advisable to make use of long range fire on the offensive than on the defensive."

Some Russian writers, on the other hand, state that a long range fire by the offensive, in return to that of the defensive, is necessary in order to create a superiority over the latter, and that the fire of an assailant will always be more efficacious than that of the troops in position, even if entrenched, because the attackers fire at a fixed object, while the defenders fire at a moving one, and therefore have greater difficulty in judging the distance exactly. But this line of argument is not easy to follow, as the ranges must alter equally for both sides.

However, in future, it is certain that, in every action, there will be, both on the offensive and defensive, many more motives than in the past for firing far and much, and consequently the problem, of providing infantry soldiers, in some way or other, with a great quantity of ammunition, so that immediate use can be made of it, is one which greatly presses on us.

Unfortunately, it is not an easy problem, but it is absolutely necessary to put at the disposal of each combatant soldier, such a number of cartridges as may be considered sufficient to carry out the services which are expected from the weapon which he carries. This supply of ammunition, whatever may be considered as necessary, is carried partly on the soldier himself and partly on wagons, carts, or pack animals, as considered best or most suitable to the country or enemy, and which immediately follow the battalions into action as far as it is safe. If the country is unsuited to wagons or carts, pack animals must be used, and if the enemy's fire is not good, like that of the Russians in 1877-78, these pack animals can be brought right up into the firing line, as the Turks did frequently. But if the fire is good, this could not be done with impunity.

Besides the above, a general supply of ammunition is carried in the field, and it is divided into several fractions, which are distributed among the divisions and army corps. These fractions march after one another in the order of their corps, and it is intended that they should replace or replenish one another according to need.

The problem, however, is not completely solved thus, though the difficulty is, at least, much lessened; the main question being, how to bring the ammunition carried in the carts or

wagons or on pack animals into direct contact with the combatant soldier in action.

Any increased lightness in the ammunition will increase the supply that can be carried, and thus increase the facility of prolonging the fire.* Before the war of 1870-71, the French thought that the infantry soldier could carry an average weight of 66 lbs. and march from 15½ to 19 miles a day at a moderate pace over level ground in a good condition, supposing he has, as well, sufficient food and rest. But roads are usually hilly, and in war get cut up, and are not kept up in good repair, the men have little repose, with bad or indifferent food and cooking, forced marches are often made, and bad weather occurs, all of which reduce the power of the man for such work, and so fatigue him after a long march as to render him incapable of giving the best result in a fight. A number of experiments have been made in France to see if it was not possible to reduce the weight of the clothing and equipment of a soldier, that is, the dead weight which adds nothing to the vigour of a soldier, so as to increase the food and ammunition he should carry. The consequence of these experiments has been, that a French soldier has now to carry his rifle and bayonet (11 lbs.), ammunition (7½ lbs.), equipment (1½ lbs.), change of clothing (12 lbs.), 3 days' food (7 lbs.), and camp equipment (10 lbs.) ; total 49 lbs.

It cannot be thought of, with the present ammunition, to make the men *always* carry the full supply considered necessary now-a-days (100 to 120 rounds *at least*) if he has also to carry his rifle, valise and its contents, great-coat, clothing, intrenching tools, bayonet, water and food, which amount to over 60 lbs. in the English service. Under these circumstances about 7½ lbs. weight of ammunition (or 70 rounds of the Martini-Henry rifle) seems to be the utmost amount that he can conveniently carry. But the Turks, who carried nothing but great-coats, food, ammunition, bayonets and water, often carried 150 rounds on their persons.†

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* For instance, when the new English 0·298 inch bore rifle is issued, 140 rounds can be carried for the same weight as 70 rounds of the present ammunition.

† Weight of 100 rounds of English ammunition, 10·626 lbs.

,,	,,	French	,,	9·636 ,,
,,	,,	German	,,	9·240 ,,
,,	,,	Austrian	,,	9·350 ,,
,,	,,	Russian	,,	9·020 ,,

But it is a serious question now-a-days, considering the rapidity of modern wars and of the manœuvres executed during them, and also the great value of mobility in war, whether the infantry soldier should be made to carry all that he does, especially in the mountain warfare in which our troops are so often engaged, and in which any dead weight that a soldier has to carry is very detrimental to his fighting capacity. In European wars, the men are invariably billetted, unless in the actual presence of the enemy, and so there is no real necessity for carrying various articles of comfort. In hot climates, of course, the men cannot be expected to carry anything but their greatcoat, rifle, bayonet, ammunition, intrenching tool, food and water, and, in the author's opinion, the valise itself,* for carrying the great coat and extra rations and ammunition. This is all that is really required in any war, if mobility of movement is required, as the baggage wagons, even in bivouac, will always come up and be with the men during the halt, when they can get any change of clothing, etc., required. Everything else should be carried for the men. It would doubtless increase the trains, but the result would be a gain in moving power, so necessary in modern warfare. In fact, in the Franco-German war, many

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* Whatever things may be carried for the men, it should be laid down as a most stringent rule, that they should *never* part with their valises, even if empty, because if they do not carry them, all means of carrying extra food and ammunition are gone, while there is no way of carrying the great-coat so comfortably as in the valise ; the rolled great-coat, in the form of a horse collar, worn round the man, is an exquisite piece of torture and discomfort to him, especially on a hot day. Napoleon I. said "There are five things which should never be separated on service from the soldier, viz. : his rifle, ammunition, knapsack, provisions for at least 4 days, and his intrenching tool." To these, may be added, bayonet, food haversack, water-bottle, great-coat, a pair of socks, and a pair of boots. The contents of the knapsack may be reduced to the least volume possible, if circumstances require it, but the soldier should always have it with him. This is very important, because in case of necessity to lighten a soldier, the contents of the knapsack or valise may be thrown away, or put into store, but he should never part with the valise itself, though empty, as a pair of boots, socks, extra food, and ammunition may be required to be carried in it, and fresh clothing may be got in other places by requisition. The importance of this has not been realized in the English service. If it is considered advisable to carry a man's kit for him, yet he can always retain the empty valise to carry extra food, ammunition, &c., &c., on special occasions. If the valise is empty, the great-coat and waterproof sheet may be carried in it so as to leave the back cool. As an example of the importance of a soldier never parting with his valise or knapsack, see p. 325

of the German regiments had twice their allowance of baggage transport to carry the men's things for them, in order to allow the men to more easily get over long distances. By relieving the men of most of the contents of their valises, the present amount of ammunition carried by the men (see p. 300) could be well increased to 100 or 120 rounds, without impairing their marching powers.

Any quantity of ammunition can of course be always carried on the wagons, carts, or pack animals which follow an army. It increases the number of horses and wagons, but this is only a question of money, and also of organization in order to prevent its acting injuriously on the mobility of the troops.

We will now consider (1) the distribution of rifle ammunition in the different European armies; (2) their rules for replenishing under fire any expended ammunition, and (3) the deductions to be made from these, so as to obtain the best method of supply and replenishment.

These deductions may not quite agree with our authorized regulations, but war is no respecter of regulations, and we should always be prepared with alternative methods to meet contingencies.

(1) The Distribution of Rifle Ammunition in the Different European Armies.

Although the following numbers may not be exact (as they are sometimes altered), they are, however, very near the truth. The broad principle used in every army, as far as both infantry and artillery ammunition is concerned, is to have certain "parks," "columns" or "echelons" told off to the infantry divisions and to the army corps, which are supplied from either mobile or stationary depôts established in rear of the army, either before, or during the war.

Germany.—In the German Army, the ammunition is carried partly—

1. By the soldier.
2. By the company baggage wagons.
3. By company ammunition wagons.
4. By ammunition "echelons."

Each *soldier* carries 100 rounds on him; non-commissioned officers only carry 30 rounds each.

Each *company* of 250 men has a baggage wagon, in which 2,880 rounds are carried in 3 boxes, giving 11·5 rounds per man, but as these wagons do not accompany the troops on the battle field, this supply cannot be counted on as available for the troops in action. It is meant to fill up the pouches during a halt, when no other supply is available.

With each *battalion* are four company ammunition wagons drawn by four horses, carrying 38,400 rounds in all, in forty boxes, containing 960 cartridges each, or 38·4 rounds per man. Each wagon has six canvas ammunition bags, each capable of holding about 500 rounds. Two or three men per company are told off to accompany this wagon to bring the ammunition in it to their respective companies. The company ammunition wagons are painted grey, to distinguish them from the artillery ammunition wagons, which are painted blue, and which are of the same pattern. This difference of colour between wagons for the two arms, which is only a simple matter of detail, greatly facilitates the supply, and is considered very important.

The ammunition wagons are driven by men belonging to the battalion to which they are attached. Each battalion has besides, two non-commissioned officers and two men always trained in the conducting and maintenance of the ammunition wagons. These non-commissioned officers and men are taught their duties in peace by the nearest field artillery batteries, with whom they remain four weeks, and learn to equip, load, and conduct the ammunition wagons, and are especially taught all that treats of the replacing of ammunition during and after a fight. Each non-commissioned officer is also taught what is absolutely necessary for him to know, to enable him to carry out the duties of a convoy commander.

But the drivers and orderlies are taught for five months every year in the nearest cavalry regiments and field artillery batteries, to mount, groom, take care of, bridle and saddle horses; they are taught some ideas of veterinary medicine, and what they should do both in cantonments and on the march; they are also instructed in driving both from the box and as a postilion.

In each army corps of 25 battalions there are 10 ammunition columns (four for infantry and six for artillery ammunition) in charge of the artillery. Each infantry ammunition column

has 21 wagons of infantry ammunition.* These 10 columns are divided into two "echelons," each of two infantry and three artillery columns, that is, one infantry and one artillery column for each division, and one ammunition column for the corps artillery. The *first* echelon marches near the troops, the *second* echelon with the train in rear.

The *first* echelon thus forms part of the fighting body, and gives a supply of 29 to 30 rounds per infantry soldier; some supplies for cavalry, and some revolver cartridges are also carried.

The *second* echelon carries the same amount, and is to supply the first echelon, while it receives its own supplies from the mobile columns of an ammunition field park in rear, or from stationary depôts.

France.—In the French army the ammunition is carried partly—

1. By the soldier.
2. By battalion ammunition wagons.
3. By ammunition parks.

Each *soldier* carries 78 rounds on him,—36 in his pouches and 42 in his knapsack.

Each *battalion* has told off to it a 4-horsed ammunition wagon, containing 18,144 cartridges, or 18·1 rounds per man. These wagons consist of a fore and hind part connected by a trail (like that of a gun) fixed to the hind part and hooking on to the forepart. Three removable chests are placed on this framework, one on the fore part and two on the hind part. The cartridges are packed into the chests in 36 canvas bundles, with handles;† each of these bundles contains 28 packets of 6 cartridges. Thus each chest contains 36 bundles, or 1,008 packets, or 6,048 cartridges. A chest can be filled or emptied in 5 minutes by three men, one to load or unload, and two to hand up or take away the bundles. Each wagon also carries 12 extra canvas wallets or bags for the transport of the cartridges from the wagons to the soldiers.

* The infantry ammunition columns are each composed of 21 ammunition wagons, one battery wagon, one forge, and one baggage wagon. It is further sub-divided into two divisions, one consisting of 12 ammunition wagons only, and the other of nine ammunition wagons, the battery wagon, the forge, and the baggage wagon.

† As the French use solid metal cartridge cases, they can be carried about uninjured in such bundles: but the English cartridges of rolled sheet brass, must be put into strong, heavy, wooden boxes, or else they would be soon knocked out of shape, or otherwise damaged.

and some few accessories, such as a spare pole, grease box, pickets and picketing rope, a pair of spare traces, a maul, lever, small pick and shovel, etc.

These wagons are reported to have proved very successful. They are stated to combine the conditions of solidity and mobility desirable, being easily drawn along the most difficult roads, across streams, up steep slopes, and in fact, capable of being taken wherever it is possible for a wagon to pass, while they have always been able to be kept a convenient distance from the fighting line, except in some special cases where the operations took place in such close or cut-up country that it would have been impossible to move even the lightest cart through it. But large operations are rarely carried out in such countries; and in such cases it is always necessary to provide a special system of supply by means of pack animals.

The drivers of the battalion wagons are men taken from the battalion, wear the same uniform, and are exercised in driving wagons, either with the artillery or the Military Transport department in the garrisons in which they are.

The *army corps ammunition park* is in the charge of the artillery, and is divided into two echelons. The *first* echelon furnishes a first supply to the infantry and batteries of the army corps. It is divided into six sections. The first two sections (*i.e.*, one for each of the two divisions of the army corps) are told off for the transport of the infantry ammunition, and carry 16·4 cartridges per man; the remaining four sections are specially told off for the transport of artillery ammunition, (*i.e.* 1 section for the artillery of each of the two divisions, and 2 sections for the corps artillery).

Each of the two sections (for infantry ammunition) of the first echelon of the army corps park, consists of—

32 4-horsed infantry ammunition wagons.
1 4-horsed forge wagon.
1 6-horsed forage wagon.
3 2-horsed provision wagons.
1 4-horsed battery wagon.

Total 38 wagons in a section.

The ammunition wagons are like those already described, and each contains 18,144 cartridges, but in each section the fore chest of one wagon is told off for revolver cartridges, and thus the supply carried by each section of infantry ammunition is 574,560 rifle cartridges and 11,285 revolver cartridges.

The *personnel* for the direction and leading of each section

is furnished by the artillery of the division to which it is told off to especially supply, and consists of one captain, and two lieutenants from the reserve forces, one quarter-master, six assistant quarter-masters, one chief artificer, one quarter-master sergeant, six foremen, one master and two assistant farriers, two blacksmiths, two carpenters, six pyrotechnists, two harness makers or saddlers, two trumpeters, and about 150 drivers.

The second echelon of the army corps park carries 33 cartridges for each infantry soldier, and artillery ammunition for the replenishing of the sections of the *first* echelon. It carries besides some spare articles, and the necessary stores for the repairs of artillery. It is divided into four sections. Each of the first three sections consists of :—

3	Gun carriages for the 3·543 inch gun.
1	,, ,, ,, 3·150 ,,
18	Artillery ammunition wagons for the 3·543 inch gun.
4	,, ,, ,, ,, 3·150 ,,
15	Infantry ammunition wagons.
1	Revolver ammunition wagon.
1	Forge wagon.
1	Harness wagon.
1	Forage wagon.

Total 45 wagons in section.

No. 4 section of the *second* echelon of the army corps park is almost entirely devoted to carrying artillery ammunition, but it has three wagons of revolver ammunition for the combatants of all arms, each wagon carrying 33,858 revolver cartridges.

The infantry and revolver ammunition wagons are like those already described, and therefore each of the first three sections carry 272,160 rifle cartridges.

The *personel* for the direction and leading of each section of the *second* echelon is furnished by the corps artillery, and consists of one captain, two lieutenants, one adjutant, one quarter-master, six assistant quarter-masters, one quarter-master sergeant, one master and two assistant farriers, two harness makers or saddlers, two trumpeters and about 370 drivers.

There is no special reserve of rifle cartridges for the other arms besides infantry, but they can draw on the infantry reserve when necessary.* However, for the independent

* This shows the advantage of having one cartridge for all arms.

cavalry divisions, a reserve of three wagons per division is made, in which the fore chest of each wagon carries revolver cartridges, and the hind chest carbine cartridges.

Behind the army corps parks comes the army park, comprised of five similar echelons for the intermediate supply between the stationary magazines and the army corps parks.

AUSTRIA-HUNGARY.—In the Austro-Hungarian army the ammunition is carried partly:—

1. By the soldier.
2. By company ammunition wagons.
3. By divisional and army corps parks.
4. By army parks.

Each *soldier* carries 100 rounds on him,* but when an action is expected to begin, each man is given a supplementary packet of 20 cartridges, taken from the company wagons, which gives 120 rounds for his immediate disposal, but technical troops (engineers and pioneers) only carry 30 rounds each, while all non-commissioned officers have only 20 rounds each. These numbers refer to the ·43 inch calibre rifle, but the future Austrian rifle is to have a calibre of ·315 inch, and 145 of the new cartridges weigh the same as 100 of the present ones. This would enable each company wagon to carry about 10,000 rounds instead of 7,000, and the other parks would also carry, if considered necessary, a proportionate increase.

Up to 1887 each *battalion* of 800 men had two four-horsed ammunition wagons each carrying 21,000 cartridges (42,000 in all), or 52·5 cartridges per man. These wagons were somewhat similar in shape and principle to the French ones, and were supplied from the divisional parks. Each wagon was under the charge of a non-commisioned officer.

But these battalion wagons, which are only old artillery

* It is interesting to note also how these 100 rounds are carried. 60 rounds are carried equally divided in two pouches placed in front, and the remaining 40 are carried in a larger pouch fixed behind under the knapsack. This pouch has three divisions, two for the ammunition, and the third for two rations of meat, and two rations of preserved soup. The bread bag of waterproof material can also be used for carrying ammunition. The three pouches and the bread bag are fixed on the waist-belt independently of the knapsack straps, so that the knapsack can be removed without depriving the soldier of his reserve rations or all his ammunition. The author invented an equipment which had these advantages, and which the Equipment Committee recommended for adoption in 1884, but it appears to have gone the way of all other service inventions.

wagons transformed, were considered too heavy to follow infantry easily, and in 1887, four company ammunition wagons, each under a non-commissioned officer, were substituted for them. These company wagons are made of iron, with a fore and hind part connected by a trail, like the artillery wagons, and are drawn by two horses. The rear part contains six cases of 1,000 rounds each. The fore part has two compartments, one above the other; the under one carries 1,000 cartridges, and the upper one carries certain accessory tools and stores, such as a pail, a bottle of oil, lanterns, &c., and pickets for the horses; six bags are also carried in it for conveying cartridges to the firing line. The forage for the team is carried on the fore part. The weight of wagon completely equipped and loaded varies from 1,830 lbs. to 1,980 lbs. according as it carries, or not, a spare wheel, pioneer tools, a lever, &c. Thus each company ammunition wagon carries 7,000 rounds, making the battalion supply 28,000 rounds, or 35 rounds per man.

The old battalion wagons have been equally distributed between the divisional and army parks, increasing the supply carried by these parks by 26 rounds per man.

A divisional park corresponding to the German and French *first* echelon is told off to each infantry division of 14 battalions forming part of the army corps, and provides 48 cartridges per infantry soldier and 89 rounds per 3·543 inch gun. It has 39 wagons, 200 horses, and about 200 men.

The *army corps ammunition park* does not supply the divisional parks, but it only fulfils the same service to the troops not attached to the divisions,* as the divisional parks do for the divisional troops,† and thus it only carries—

15 rounds per rifle of the technical troops.
18 ,, ,, revolver.
18 ,, ,, cavalry carbine.
74 ,, ,, 3·150 inch gun.
82 ,, ,, 3·543 ,, ,,

and a certain quantity of powder and dynamite.

The army corps ammunition park consists of 51 carriages, 260 horses, and 250 men.

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* Such as the corps artillery, corps engineers, &c.

† Thus the divisional and army corps parks are practically only different sub-divisions of the same line of ammunition supply.

Independent infantry divisions have a special divisional park which carries:—

10 rounds per infantry rifle.
15 ,, ,, rifle of the technical troops.
35 ,, ,, cavalry carbine.
18 ,, ,, revolver.
100 ,, ,, 3·150 inch gun.
110 ,, ,, 3·543 ,, ,,

The above different parks form what is called in Austria the "first line of the artillery reserve establishments." They replenish themselves from the "2nd line of the artillery reserve establishments" which consists of:—

(*a*) *The army ammunition park*, which carries,
32 rounds per infantry rifle.
6 ,, ,, rifle of the technical troops.

(*b*) *The army reserve ammunition park*, which carries,
24 rounds per infantry rifle.
15 ,, ,, rifle of the technical troops.

(*c*) *The army field ammunition depôt*, which carries,
60 rounds per infantry rifle.
22·5 ,, ,, rifle of the technical troops.

Russia.—In the Russian army the ammunition is carried partly:

1. By the soldier.
2. By battalion and regimental carts.
3. By field ammunition parks.

Each *soldier* carries 84 rounds on him,—30 in his pouches and 54 in his knapsack. In 1877 they only carried 60.

Prior to 1886 each *battalion* had four ammunition wagons (one to each company). Each wagon carried 945 packets of 12 cartridges each, or 11,340 cartridges which gave 60 rounds per man. These wagons were conducted by men belonging to the company, and were commanded by a non-commissioned officer.

By an order dated 17th June, 1886, there are to be 33 two-wheeled one-horse ammunition carts per regiment of four battalions, that is 16 carts for the 16 companies of the regiment, and 17 to form a general regimental reserve. The supply carried by the 33 carts is 153,504 cartridges or 48 rounds per rifle for an effective of 3,200 rifles. This ammunition is carried in 533 zinc cases, 16 of which are carried in each cart. Each case carries 288 rounds. The

regimental ammunition train is formed into two groups, one formed of eight company carts is to march immediately behind the troops, and the other formed of the other eight company carts, and the general regimental reserve, is to march in rear of the column. This regimental ammunition train is commanded by an ordnance officer.

The *field park* is formed of two echelons, the first called the *flying park* (corresponding to the German and French *first* echelon), and the second the *mobile park* (corresponding to the German and French *second* echelon).

There are two kinds of flying parks; the *divisional flying parks* told off for the supply of the infantry divisions, and the *cavalry flying parks* told off to the independent cavalry brigades and divisions.

Each *divisional flying park* carries 52 rifle cartridges per infantry soldier, it consists of 5 sections (2 for infantry and 3 for artillery) and an intendance train. It is commanded by a field officer of at least the rank of lieutenant-colonel.

An infantry section has 32 four wheeled wagons and a tool wagon, and its *personel* is two officers, 1 clerk, 9 non-commissioned officers, 171 combatant men, and 15 non-combatants.

An artillery section has 22 four-wheeled wagons and its *personel* is 2 officers, 1 clerk, 9 non-commissioned officers, 121 combatant men, and 15 non-combatants.

The intendance train consists of a wagon for money and correspondence papers, 5 wagons for food supplies, an ambulance wagon, and a medical cart.

A *cavalry flying park* consists of a section of 24 four-wheeled wagons, a tool wagon, and an intendance train, commanded by a captain, who has under him 1 lieutenant, 1 clerk, 9 non-commissioned officers, 91 to 131 combatant men, and 18 non-combatants.

In Russia there are 48 divisional flying parks, corresponding to the 48 infantry divisions and 30 sections for cavalry flying parks.

Each *mobile park*, carries 13 rifle cartridges per infantry soldier. It is divided into four sections, each composed of 48 four-wheeled wagons and an intendance train. The *personel* of a section is 1 captain, 1 lieutenant, 1 clerk, 9 non-commissioned officers, 200 combatant men, and 25 non-combatants.

There are 14 mobile parks in Russia, but they have no *cadres* in peace time, when the material is placed in the artillery depôts and the stores.

Besides the above, *reserve depôts* are made in war time, and established at the base of operations at first, and carried forward according to circumstances. These depôts are of different kinds, namely:—

(*a*) *The field ammunition depôt*, which acts as a reserve to the field parks, whose supplies it renews.

(*b*) *The advanced artillery depôt*, which furnishes the artillery with a reserve of men, horses and material, and to all troops a reserve of small arms (including swords, lances, etc.,) but not of ammunition. To this depôt is attached a workshop for repairs.

(*c*) *Provisional Depôts* for fire-arms.

The composition of these different establishments is determined when war breaks out, according to the needs of the moment.

TURKEY.—In 1877-78, when the country presented no difficulties, the Turks carried their ammunition in two-wheeled country carts, which accompanied the battalions on the march.

When the country was difficult, as it generally was, or when going into action, pack animals were used. Each battalion had from 24 to 30, and even 60 pack animals, each carrying 2 zinc-lined boxes containing 1,000 cartridges each. The men also carried 150 rounds each in their pouches, pockets, and haversacks.

In the Turkish army in 1877-78, the battalion was the administrative unit, and its officers were responsible for the purchase of the men's food (usually sheep, which marched with the troops), and for procuring pack animals as well. In a battalion of 400 men the battalion train consisted of 80 pack mules or horses, but some battalions in Armenia hired or bought camels for the transport of their baggage. 10 animals were told off for the tents (four tents for 11 men each per animal), 20 for the ammunition supply (2,000 rounds per animal, or 80 per man), 10 for the tools and cooking utensils, 10 for the officers' baggage, and the remaining 30 for the transport of five days' biscuit and food supplies.

ENGLAND.—In the English army the ammunition is carried partly*:—

* In the G.O. for July 1878 and for October 1887, the different lines of ammunition supplies are designated as the battalion, divisional, and army corps "reserves." The words "supply" and "columns" are purposely used here instead of the word "reserves," as the functions of these columns are in no way those of a reserve, because their supplies are for actual use, when required, and are not for being kept back or parsimoniously issued, as the word "reserve" implies.

1. By the soldier.
2. By battalion ammunition carts and pack animals.
3. By the battalion baggage wagons.
4. By divisional ammunition columns.
5. By army corps ammunition columns.

Each *soldier* carries on him 70 rounds,—40 in his pouches and 30 in his valise.

Each *battalion* has 4 two-horsed two-wheeled ammunition carts, each carrying 7,200 rounds (28,800 in all), or 30 rounds per man. Each cart carries 12 boxes of cartridges each containing 600 rounds, or 7,200 rounds in all. The cartridges are made up in packets of 10 rounds each. The drivers are taken from the battalions. Two pack animals accompany the small arm ammunition carts.

Each box with its contents weighs about 80 lbs.; the lid of the boxes slide in, and is then fixed with a pin attached to a tape held down with sealing wax. These are easily opened, but before 1880 the lid was screwed down, so that it was difficult to get at the ammunition, especially if the screw-driver was lost, which often happened, when the box had to be broken or prised open by some means or other.

The carts are of special design, and are fitted with six small and one large compartment each; each of the small compartments carries two small arm ammunition boxes, and the large compartment carries a few entrenching tools. In a locker under the cart, 480 rounds of pistol ammunition are carried. These carts, therefore, cannot be used for any other purpose.

Each cart has a leather pocket outside, in which the necessary tools are placed, and two canvas bags for distributing the cartridges are carried in a shallow well under the cart. Two such bags are also provided per company, and are worn by two men of the company for the same purpose. This gives 22 canvas bags per battalion.

These canvas bags are made with two pockets, each 13 inches wide by 16 inches deep, connected together by a canvas strip of double thickness, in which arm-holes are cut so that it can be put on like a waistcoat. Such a canvas bag, or rather pair of bags, can be placed on the shoulders of a man or on a pack animal (one pocket lying on either side). The pockets can each hold 200 rounds, or 400 in all, giving a weight of about 43 lbs.

If pack animals are used instead of carts, 24 to 25 animals are required per battalion to carry this ammunition, as one

animal can only carry two boxes or 1,200 rounds, which with the packsaddle, cover, straps etc., weigh 206 lbs. or nearly 15 stone, exclusive of forage, picketing gear, blankets, and grooming necessaries.

Each division of 7 battalions has a *divisional ammunition column* (in charge of the artillery of the division to which it is attached), which for manœuvring purposes is divided into two sub-divisions, each composed partly of artillery ammunition wagons, and partly of infantry ammunition carts.

These sub-divisions carry between them a divisional reserve of 40 rounds of rifle ammunition per man. The carts are the same as those attached to battalions.

The army corps ammunition column is organized in three sections, each carrying a full supply for one divisional ammunition column (that is, 30 rounds per man of small arm ammunition). Although these sections are, as a rule, kept together, yet this sub-division was instituted so that any division sent off on detached duty can, when desirable, take its second line of ammunition supply with it. This army corps ammunition supply is under the corps artillery commander. The small arms ammunition in it is carried in wagons and not carts.

Ammunition depôts, containing at least 320 rounds per rifle in the field, are organized in rear under the Ordnance Department.

Thus we see that there is no special or separate provision for the corps artillery, or even for the divisional artillery, as prevails abroad, but as there are three divisions in an English army corps, each divisional ammunition column carries one-third of the artillery supplies for the corps artillery in addition to those for the divisional artillery. This is a very defective arrangement, because if one division is detached with its ammunition column, it takes with it one-third of the supplies for the corps artillery which remains with the other two divisions. The French, German, or Austrian subdivision, which allots a distinct section or unit to the divisional infantry, to the divisional artillery, and to the corps artillery, is much to be preferred.

With regard to the mode of conveying the ammunition, whether on wheels or on pack animals, it is a question to be decided by common-sense and the nature of the roads. If the roads are good enough, wheeled transport is a saving of horses, attendants, food, &c., because a 2-horsed cart carries at least as much as eight pack animals. If the roads are bad and carts cannot travel, pack animals must be used.

Where small forces are engaged, as in our savage wars, they cannot protect the zone of territory in rear for any distance, and hence the ammunition supplies, beyond those of the battalion, must be kept close to the force. They are usually called the "second reserve of ammunition," the immediate battalion supply being designated the "first reserve of ammunition."

In Afghanistan the ammunition provided and kept up in the field was, for cavalry and sappers, 200 rounds per man; for infantry, 500 rounds per man; and for the artillery, 500 rounds per gun. The rifle and carbine ammunition was thus distributed: cavalry and sappers carried 40 rounds on their persons, and the infantry 70 rounds. The infantry had a first reserve of 30 rounds per man, which accompanied each battalion; the cavalry and sappers had no first reserve. In the second reserve, the infantry had 200 rounds per man;* cavalry and sappers, 60 rounds per man. In the stationary "ordnance field park reserve," there were, for infantry, 200 rounds per man; and for cavalry and sappers, 100 rounds per man. All except the last reserves were carried on mules.

In Ashantee, where both wheeled transport and pack animals were out of the question, each infantry soldier carried his 70 rounds, and a battalion reserve of 50 rounds per man was carried by coolies under a non-commissioned officer, each coolie carrying one box on his head. A further reserve in addition to this, of at first 50, and subsequently 70, rounds per man, was carried by similar means, and had its place in the column of route under the charge of the artillery. As some of the troops fired away 100 to 120 rounds in the bush fighting, they had to be supplied during the action, and as the boxes took some time to open, because the lids were then screwed down, the boxes of both the battalion and first reserve of ammunition were kept unscrewed.

Thus we see that all the different armies echelon their ammunition in much the same manner, although the distribution of the ammunition in the different echelons is not the same. The battalion and other supplies form successive magazines of ammunition. Evidently no ammunition beyond that carried in the army corps ammunition columns can be immediately available on a battle field; and, indeed, only the leading echelons of these columns can be so. In the following

* This large supply was necessitated by the fact that the marching columns were frequently several days' marches away from any stationary depôt of ammunition from which any fresh supply could be obtained.

table the ammunition supplies for replenishing the army corps columns, being a matter of ordinary supply, will not be considered. Calling the various echelons by the names of those corresponding to them in the English organisation, we see that the distribution of the ammunition, in the different European armies, is as follows:—

TABLE XIX.

Method by which the Ammunition is carried.	Supply of Cartridges for Combatant.					Remarks.
	Germany.	France.	Austria-Hungary.	Russia.	England.	
By the men*	100	78	100	84	70	
In battalion wagons	38·4	18·1	35	48	30†	† A further supply of 11·5 rounds per man is carried in the German service, and 10 rounds per man in the English service, in the company or battalion baggage wagons, but which may not be available on the battle-field.
Total of first supply for fighting line... ...	138·4	96·1	135	132	100	
In divisional or first line of ammunition columns	29·5	46·4	48	52	40	
General Total of supply for field of battle... ...	168	142·5	183	184	140	
In army corps or second line of ammunition columns	29·5	33	32	13	30	

These numbers are based on the battalion being at full strength, but if we consider the men absent from the ranks in war time from sickness, wounds, or deaths, and that the car-

* Thus the weight of ammunition carried by the men of different nations are as follows:

By the German soldier	.. .. ..	7·392 lbs.
,, French ,,	.. .. ..	7·515 ,,
,, Austrian ,,	.. .. ..	6·545 ,,
,, Russian ,,	.. .. ..	7·517 ,,
,, English ,,	.. .. ..	7·438 ,,

In G.O. 161, of October, 1887, it is stated that when the new small-bore rifle (0·298 inch) is introduced into the service, the amounts in the above table will be greatly increased, and that a soldier will be able to carry 140 rounds for the same weight as that of the Enfield-Martini rifle, which has a lighter cartridge by 100 grains than that of the Martini-Henry rifle.

tridges of the killed and wounded should invariably be used, and that, even in the most hotly contested actions, all the troops present are rarely engaged, so that the supplies carried for these can, if required, be utilised by the troops firing, we find that with ordinary precautions for supplying the men, each man may be supposed to have from 120 to 150 rounds at his disposal in action, and have a further supply ready for him at the end of the day.

The Russians say that each soldier requires 120 cartridges at least to be on him, to carry him through an action.

The officers commanding battalions are responsible for the ammunition carried by the men and in the battalion wagons; the artillery is responsible for the first and second lines of ammunition supplies; the depôt supplies in the English service are in the charge of the Ordnance Department.

There can be no doubt that if long range fire is not used, if a rigid fire discipline is maintained, and if the troops are only pushed forward within the medium zone, *after an efficient artillery preparation*, 70 to 100 rounds are sufficient to carry out an attack. But if long range fire is used, with no fire discipline, and the troops are pushed forward to close ranges before the necessary artillery preparation is completed, then no limit can be put on the number of rounds that will be expended, but past experience shows that long range fire is only permissible when the immediate available supply of ammunition is *at least* equal to 120 rounds per man, and the means of replenishing the expended ammunition comparatively easy and ample.

Rules for Replenishing Expended Ammunition.

The above supplies of ammunition only solve half the problem of replenishing the spent ammunition. The cartridges are on the battle field, more or less near the men according to the ground, and especially according to the circumstances of the fight. It now remains to consider how to render them available for the troops engaged—*i.e.*, how to transport them from the echelons in rear to the echelons in front. This is the most difficult part of the problem, and the following remarks will show how the various Continental nations hope to solve it.

Germany.—The company ammunition wagons are to place

themselves, from the beginning of the action, close to the troops which they have to supply, and in as sheltered a place as possible. A non-commissioned officer always remains with each wagon, and shows its situation at once by means of a white flag with a black square in the middle, placed to one side and at a distance fromthe wagon, on a spot where it can be easily seen. At night this flag is replaced by a green lantern. This flag or lantern simply shows a depôt of supply, and it is laid down as a principle that any troops engaged are to be supplied from any wagon whatever.

If circumstances require it, the connection between the battalion and its ammunition wagons may be assured by mounted orderlies.

As soon as the battalion has taken position and the action begins, two or three men per company and a non-commissioned officer, told off beforehand, who have been previously exercised in this duty, proceed to the wagons and take off their knapsacks, and anything that will hinder their movement, as they ought to have no other occupation than that of fulfilling the duty with which they are charged.

The non-commissioned officer, who has charge of the men gives to each of them a canvas bag capable of carrying 500 cartridges (44 lbs.) which is considered the limit of weight which one man can carry to a considerable distance or over difficult ground. They then return to the engaged companies, distribute the ammunition they carry, return without orders, and continue this coming and going as long as necessary.

Latterly, however, the Germans and Austrians have considered that no reliance is to be placed on schemes for supplying attacking troops in this way with fresh ammunition during the final stages of an action—*i.e.*, under 500 yards. They consider further that 24 lbs. weight, or 12 packets of 20 rounds each, or 240 rounds in all, is all that a man can be reasonably expected to carry. Each of his journeys would take at least thirty minutes, going and returning from the fighting line to the second line, where the battalion ammunition wagons are supposed to be stationed. Assuming that the firing line of a company, in an attack, is supplied with ammunition by means of from three to six carriers (one or two per "zug"), three such men, for example, will be able in thirty minutes to convey to the fighting line only 720 cartridges, or say four cartridges for each man of the company. From this it is clear how great are the efforts, and how long is the time required to replenish the ammunition,

which can be expended in less than a minute, even with very deliberate firing.

Therefore, on the offensive, the men ought to be fully supplied with ammunition *especially before the attack begins*, and the carriers should begin their work as soon as the firing has commenced, in order to prevent as far as possible the ammunition running short, because *a sufficient supply for infantry is a necessity for its very existence*, and consequently such a condition must be accorded a complete and ample satisfaction.

When previously-selected positions have to be defended, it is laid down that small depôts of ammunition are to be established along the line.

The replenishing of the ammunition ought to be assured beforehand on the defensive by supplies brought up close to the troops who fire; on the offensive, the full supply of ammunition must be served out before throwing the troops forward in the attack; under fire, also, the cartridges of the killed and wounded should be utilized.

It is reported that the Germans have decided to serve out 20 cartridges extra to each man before he enters into action, pockets being specially made in the tunics to receive the supply.

More ammunition may be given to men on the defensive than in the attack, because they can lay it on the ground.

As a general rule the battalion wagons may be expected to be within 880 yards of its battalion in action; the wagons of a regiment (three battalions) or a brigade (two regiments) may be collected together if necessary; and if the case is urgent, an ammunition wagon can be taken at full gallop up to the fighting line.

All troops engaged have the right to supply themselves at the wagons situated nearest to them, whether they belong to them or not. The battalion wagons are replenished by the first echelon of the army corps ammunition column.

The battalion adjutant is especially charged with looking out that the service of supply is well carried out. Directly a wagon is empty it ought to be at once sent to the nearest echelon of the ammunition column, and exchange its empty boxes for full ones. But as this method of proceeding may cause a delay in the supply, the commander of the first ammunition echelon can, if he thinks fit, and must, if he receives the order, send some of his wagons to the points where the ammunition seems to be becoming quickly consumed from the amount of fire, so that an empty ammunition wagon

may be rapidly replaced by a full one, while it goes to the first echelon to be refilled, and then returns.

The empty wagons of the first echelon are sent as soon as possible in groups of four or five under a non-commisioned officer to the second echelon of the army corps ammunition column, where they remain temporarily. In their place an equal number of full wagons are sent to the first echelon from the second.

When an ammunition wagon goes to be refilled, a provisional receipt is given for the ammunition taken; but a regular one is given later on when the supply is regularly replaced after the action.

FRANCE.—In a regiment (of three battalions) the *personnel* specially told off to the battalion wagons includes a chief artificer, who is mounted, and is charged with the general superintendence of all the regimental wagons; a non-commissioned officer and two soldiers are further told off to each battalion wagon, who mount on the wagons when only these latter are moving rapidly. The replenishing of the supply carried by the troops themselves is only made from the wagons after all the cartridges, taken away from any dead, wounded, or other men for any reason, have been used up. The battalion wagon is refilled as soon as possible by the ammunition parks, on the order of the battalion commandant.

The cartridges of men placed *hors de combat* are carefully collected for distribution among the combatants; any in excess, after completing the individual supply, is placed in the baggage wagons, or in wallets carefully tied up; cartridges are only returned to the ammunition parks, when there is no means of carrying them with the corps.

On the field of battle the battalion wagons are kept together regimentally; only exceptionally do they accompany their respective battalions. Their position is assigned to them by the officer commanding the regiment or battalion, and they are, as far as possible, to keep themselves concealed from the view of the enemy. They should not be more than 1,100 yards from the firing line, but this distance may be decreased when cover is available: in all cases they must keep as near as possible to the firing line. At critical moments the commanding officer may direct them to be moved up rapidly to the firing line. Their position is marked by day by a yellow flag, placed, as far as possible, well to a flank, so that it may not afford a mark for the enemy; and at

night by a yellow light.* On the field of battle, horses required to replace those in the battalion wagons are drawn from the ammunition sections, on the order of the general of the division, or, in cases of urgency, of the brigadier.

One or more extra packets of cartridges are to be issued to the men before joining the firing line, and every favourable moment, every pause in the fight, every lessening of the enemy's fire, &c., is to be seized for renewing the supply. In important defensive positions, depôts of ammunition may be established along the line, and even the battalion wagons may be posted there, provided cover can be obtained for them. Obtaining ammunition by sending men for it from the front, is absolutely forbidden: it is to be brought from the wagons to the firing line by men taken from the reserve companies, told off for the purpose: no man is to be taken from the firing line for this purpose. Each of the men, told off for the duty of supply, carries a double wallet, twelve of which are in each wagon.

In the double wallet 56 packets of cartridges are placed. The weight of a wallet thus loaded is about 37 lbs., and it is carried slung over the shoulder, one pocket in front, the other behind. If time presses, the bundles of 28 packets, in which these packets are made up, need not be opened before placing the packets in the wallets, but the breaking up is preferable. The bearers of the wallets distribute the packets of cartridges among the men firing, returning to the wagons for a fresh supply when the contents of the wallets are exhausted. If a battalion wagon has to supply troops other than those to which it is attached, the non-commissioned officer in charge of the wagon makes the issue on a voucher, or, in default of one, on a simple memorandum, even written in pencil, but signed by the commanding officer of the battalion, and bearing the number of the company, battalion and regiment to which the ammunition is issued, the amount of the demand, and the rank and signature of the individual making the requisition. As a rule, when the battalion wagons are grouped together, one is emptied before any ammunition is issued from another; the chief artificer, being responsible for the replenishment of his supply, must consequently know where the nearest ammunition section is

* The small arm ammunition sections in rear have the same yellow coloured flags and lanterns; the artillery ammunition sections have blue flags and lanterns to distinguish them

posted, and take care that the non-commissioned officers in charge of the wagons are also acquainted with its whereabouts. As soon as a wagon is nearly emptied, the remainder of its contents is placed in the wallets, and the chief artificer sends to the nearest ammunition section for a full wagon. This is brought up by a corporal, and its contents transferred to the empty battalion wagon, the non-commissioned officer in charge of the latter giving a receipt, specifying the nature of the ammunition delivered to him, and the hour at which he received it. The empty wagon then returns to the ammunition section from which it came.

The first echelon of the army corps park ought to be sufficiently near the troops to be able to furnish them, without delay, with the ammunition they require. Unless otherwise stated, its position will be about 1,600 yards in rear of the firing line, the sections being placed as near to the troops, to which they are allotted, as the roads allow of. They are only to remain on the roads in case of necessity, and must leave them as soon as sufficient openings and the necessary ramps have been made. The divisional and corps artillery commanders are to be informed of their arrival as soon as possible. Each infantry section is indicated by a yellow flag, and each artillery section by a blue flag by day, and at night by lamps of the same colour.

After an action, the ammunition sections are directed on points designated as "distribution centres," in order to carry out the general supply. Empty wagons are sent in groups for this purpose, under an officer. The supply is to be made by moving the ammunition from one wagon to another, and not by an exchange of wagons, which is only to be done as rarely as possible. Cavalry divisions are to be supplied by any ammunition section appealed to. Every demand for ammunition is to be satisfied, even when made by strange corps.

The second echelon of the army corps park is to be kept, as a rule, a day's march in rear of the troops, but during a battle it will be brought up nearer to the first echelon. Its sections always march united, and form a single "distribution centre", at which the empty wagons of the first echelon are refilled. The empty wagons of the second echelon are sent in large groups to the nearest army park for refilling, the position of which should have been previously made known to it by the commander of the corps artillery. Similarly, the commanders of the echelons of the army park should know the positions of

the second echelon of the army corps park, so as to put themselves in communication with it. The second echelon of the army corps park has to satisfy all demands for ammunition, by whomsoever made.

Any commander in an independent position can send a written requisition (even in pencil) for ammunition, but his demand should not exceed his immediate wants, as he can send for a further supply if necessary. Even if a demand is made without a written request, it must be acceded to, but a receipt is to be taken.

In order not to break up the bundles of ammunition, the nearest number of bundles to the demand made is sent, but an insufficient supply will allow of less ammunition being sent than the demand asked for, and a receipt for the actual amount taken is to be given. Requisitions are to be satisfied by whatever echelon or park they are presented to.

Immediately after a battle, "states" are to be sent in, showing the amount of ammunition required to re-establish the normal supply. Similar "states" are to be sent in every five days.

Austria-Hungary.—The following information has been taken from the *Revue Militaire de l'Etranger* for 15th December, 1887. It is pointed out that while the infantry has been given increased resources in ammunition, yet the Austrians try to avoid a useless consumption of ammunition by giving each soldier a particularly careful instruction in what concerns fire discipline. (See Chap. XV.) This question, which actually forms one of the principal pre-occupations of the chief commanders, and on which the Emperor himself has many times questioned the officers of the corps he has inspected, has been made the object of a special appendix to the drill regulations of the infantry. But in spite of these precautions it is considered that the expenditure of ammunition will be considerable, and hence the following rules have been laid down both for completing the supply carried on the men and for replenishing the ammunition expended.

The commanders of regiments and battalions are responsible that the ammunition carried by the men is always complete, and that it is completed when necessary.

When an engagement is expected, each man is to have given him, before starting on the march, or during a halt, 20 supplementary rounds, drawn from the company wagons; each non-commissioned officer will receive at the same time, the number of cartridges normally allotted to the men.

The ammunition wagons always accompany the troops

During an action, the ammunition wagons remain, as a general rule, near their battalions. If any companies are detached, they are accompanied by their wagons. The wagons of a regiment or group of battalions, can be collected under the commander of these troops in a single column, and placed under the command of an officer.

As soon as the combat has begun, the ammunition wagons advance, without waiting for orders, close to the reserve of their battalion, and follow its movements, taking advantage while so doing of all cover, and avoiding exposure. When the reserve enters the firing line, the wagons come up as close as possible, as near as the shelter afforded by the ground permits.

When the decisive action has been pronounced they will advance, and rejoin the battalion as soon as they can. The movement of columns, formed of all the wagons of a regiment, or of any group of battalions whatever, will be regulated on the same principles.

The situation of the wagons is shewn, during the day, by a red flag, which in an action must not be placed where it will attract the enemy's attention. The wagons will be faced to the rear, and if they are exposed to artillery fire they will be placed at intervals of 20 paces.

In the offensive, as soon as the battalion takes the formation for combat, the leading companies will tell off six to eight men, if possible from among the buglers, drummers, or infantry pioneers, who will proceed to the wagons under a non-commissioned officer. They are then each given a haversack containing 300 to 400 cartridges, which they carry back to their companies.

The subsequent replenishing of the ammunition is ordered by the commander of the battalion, or regiment, or group. The supplementary cartridges are generally carried to the firing line by the troops reinforcing it ; this duty can also be confided to the care of small detachments sent forward to the firing line under a non-commissioned officer, and who remain there.

The engaged companies profit by any pauses in the combat to replenish their expended ammunition, and to equalise the supply of ammunition between the men of the same company. The men are to take the ammunition of the dead and wounded, and to distribute it among their comrades.

In the defensive, especially in the defence of inhabited places or organised positions, the ammunition wagons can be emptied, even before the commencement of the combat, and

the contents distributed, or rather placed near the front line at certain favourable points.

The quartermaster-sergeants (*les sous-officiers comptables*) are charged with the loading of the wagons, with the distribution of the ammunition, and with the replenishing of the wagons at the divisional park. In each battalion, the senior among them takes command; he is responsible for the leading of the column during the combat—the others are at his disposal; he employs them to maintain the connection with the reserve, to reconnoitre the ground, roads, &c. He is advised by the battalion commander as to the situation of the divisional park.

In distributing the ammunition, the rear cases of the first wagon are first emptied, and then the front ones*; each wagon must be completely emptied before the next one is drawn on.

The empty wagons are formed in column by corps of troops, and taken to the divisional park, where the empty cases are exchanged for full ones. In exceptional cases, in which several wagons of a battalion (or of a regiment) have been drawn on at the same time, as many wagons will be filled up as possible from the remaining supplies, and then only the empty ones will be sent to the divisional park.

When a strange corps demands ammunition, the demand is to be acceded to, wholly or in part, according to the urgency, and to the amount of the supply.

The quartermaster-sergeant attached to each wagon is to keep an account of the number of cartridges distributed, both to his own and to strange corps; the issues are to be made, however, without written demands or receipts.

These instructions present three particularly interesting points.

(*a*) The distribution of a supplement of 20 cartridges before entering the fight, making the personal supply 120 rounds,—an excellent measure, which increases the confidence of the soldier, and allows the fire to be given all the energy possible, from the beginning of the action.†

* The reason of this is in case any of the horses are killed or wounded, and a retreat has to be made rapidly, or if some ammunition has to be rapidly sent to troops in a critical position, then the rear part can be unlimbered, and the horses can gallop away with the fore part. Thus, in case of retreat, some of the ammunition is saved, the enemy only capturing the empty rear parts.

† The Austrians were the first to institute this precaution. Their example has been since followed by both the French and Germans.

(b) The replenishing of the ammunition by the troops of the supports, who carry it forward with them, and distribute it. This method of proceeding would certainly be best of all, if it could be proved, firstly, that the troops of the support always moved up to the troops in the firing line requiring to be supplied, for it often happens that this line is reinforced by extending it, or by sending the supports into the gaps, and secondly, that a soldier would consent, when once in the firing line, to give up for the profit of his neighbours a part of the ammunition which he carries. This latter point can be practically got over by discipline, and training the men to the idea of mutual co-operation, and by giving them more ammunition than they can conveniently hold while using their rifles. It has, however, in all cases, the great merit of not taking men from the firing lines, and if it is not always applicable yet such a practice will be very useful in many cases.

(c) The direct subordination of the ammunition wagons to the battalion and regimental commander.

Russia.—The latest Russian regulations for the supply of infantry ammunition in battle appeared in June, 1886. The substance of them is as follows:—

At the moment when the troops quit the formation in column of route, in order to take the formation of assembly, the company (or squadron) ammunition wagons, which immediately follow the troops, form up 20 paces behind their regiments or battalions in one line or in two lines, 15 paces apart. The interval between the wagons is two or three paces.

If, in the formation of assembly, the battalions are formed up in line, the ammunition wagons are posted as above; but if, on the contrary, the regiments or battalions are formed up one behind the other in column, then according to the orders of the commander of the column, the ammunition wagons will be posted either immediately behind the fraction to which they belong, as above, or in rear of the column in several distinct lines, 15 paces apart. The wagons of each regiment (or isolated battalion) will form one line only.

At the moment when the troops pass from the formation of assembly to the formation of combat, the commanders of the different units give some general instructions to the ordnance officers *(officers d'armement)* in charge as to the position to be taken up by the ammunition wagons, according to the ground and the exigencies of the combat. In open ground they ought

not to be further from the firing line than the regimental reserves (third line); if, on the contrary, the ground offers any shelter, they can be placed behind the battalions of the second line, and even behind the companies forming the battalion reserves of the first line. According to the nature of the combat or of the ground they can also be apportioned between the battalions.

The ordnance officer in charge of the wagons is to post them as much as possible under shelter from fire, while conforming to the orders he has received from the commander of the troops. He must inform this commander of the place chosen, who in turn informs the officers under his orders. During the action the ordnance officer must remain near his wagons, and take every means to satisfy all the demands for ammunition coming from the firing line. Also he must follow the course of the engagement, and in the case when, from the circumstances of the fight, he has not received in good time the order from the commander of the troops, he must not hesitate to take on himself to advance or retire the wagons, according to the new conditions of the fight, in order to be always able to furnish ammunition everywhere where it is necessary.

If the wagons are apportioned to battalions, they are posted and moved according to the orders of the battalion commander, who tells off a non-commissioned officer to lead them. The same remark applies to a detached battalion or company. The wagons then pass under the orders of the commanders of these units and follow them. When possible, a mounted non-commissioned officer of the regimental train should be chosen to command the wagons of a battalion. If this is not possible, a senior non-commissioned officer is chosen, and the *rôle* he plays is the same as that of the ordnance officer.

The position taken up by the ammunition wagons is marked by day by a red flag, and by night by a green lantern. These signals should be so placed as not to draw the fire of the enemy on the wagons.

In the offensive, according as the ground permits, the wagons join the engaged units, or remain in rear. Thus they can be taken to the reserve battalion of the regiment, or to the companies forming the battalion reserve, or even to the firing line. If they cannot at once join the firing line, the replenishing is carried out by successive demands made on the units in rear, who in turn are supplied by the troops in rear of them

or by the ammunition wagons, if these are not too distant. The ammunition of the dead and wounded is also to be utilised. These measures are only to be taken when it is not possible for the engaged troops to supply themselves directly from the wagons. When a unit is near any wagons and receives a demand for ammunition, it will direct the men sent for the supply to the wagons.

The Commander of any troops who require ammunition, sends 2 or 3 men to the commanders of the units nearest in rear of him. These commanders immediately make their men give up half the ammunition that they carry, and they also furnish the necessary number of men required to carry them to the troops who need them. As a rule 6 to 10 men, commanded by a non-commissioned officer, can carry the cartridges necessary for a company. If this ammunition is taken from the wagons, it is carried in the zinc boxes or bags which form part of the system of supply. In default of bags the men can use the hoods and skirts of their cloaks. When they reach the fractions to be supplied, they distribute the cartridges they have brought up, and remain under the orders of the commanders of these fractions. This measure prevents a too-frequent coming and going between the different units. Furthermore, for greater certainty, before taking the formation for combat, the men who are to be first deployed should be given a certain number of packets of cartridges, which are taken from the ammunition wagons, and which the men put in their pockets.

Every demand for ammunition is to be satisfied, whoever may be the troops from whom it emanates.

In order to replenish the wagons themselves, they are directed, according as they become empty, on the second group of the regimental train, at the head of which march the 8 ammunition wagons told off to the companies and the general regimental reserve.

In the case of a defensive combat, the cartridges are carried beforehand to a favourable point of the position. It is the duty of the ordnance officer to secure all the ammunition that has not been used up when the troops pass from the defensive to the offensive.

Such are the regimental dispositions in vogue in the Russian Army for solving the question of supply of ammunition on the battlefield. These and the Austrian regulations seem to have a very practical character.

Special attention is drawn to the method of supply, since

introduced into the English regulations, of drawing on the troops in rear, and of taking the precaution, at the commencement of the action, to immediately increase the quantity of ammunition carried by the men who are first to open fire.

Before the above regulations appeared, the Russians practised various methods, two of which are given below.

Before the action begins, each company detaches two men who accompany its wagon, and are charged with the supply of their company. These men carry the cartridges in bags close up to the firing line, one man carrying the ammunition, and the other man the two rifles, and the next journey they change duties. The ammunition bags are emptied on the ground, at a point indicated by the captain, and the men come and take their cartridges from the heap. Such a method of procedure as the above is likely to occasion great disorder in the firing line, and a downright waste of ammunition.

In 1884 another method was tried. When the officer in command of the company firing line noticed that the ammunition was running short, he made a bugler sound the "Fire rapidly," which had been previously arranged was to signify "Send forward ammunition." All the buglers of the reserve repeated this call, at which signal the officer commanding the company reserve told off two to four men, to whom the remainder of the men of the reserve* gave some of their packets of cartridges. These men placed the packets in the pockets of their tunics, trousers, and great coats, and *in their caps*, and advanced as much as possible towards the centre of the different extended sections; they laid down about ten paces in rear of the firing line, and cried out "Cartridges." They then threw the packets to the section commanders, who in turn threw them to the men in the firing line without getting up. The men who brought up the cartridges did not return, but joined the firing line, placing themselves under the orders of the nearest section commander. In this manner the supply was carried out in from seven to ten minutes. This method seems to merit some consideration. But the repeated bugle calls seem a bad institution, as the engaged companies can always communicate with the reserve by means of signals and connecting links, and if the enemy knew the custom and heard the call, they might especially

* Presumably during the practice there was no ammunition wagon present, from which this ammunition would have been taken in preference.

direct their fire on the men whom they see bringing up the ammunition.

Each company in the Russian army has a small flag of a particular colour, for the guidance of the men who supply the ammunition, so that they can easily find again the company they have to supply, and the white flag of the ammunition wagons shows them the direction to be taken to get to it.

The battalion commander is charged with the duty of ensuring the supply of his companies with ammunition. A mounted man of the regimental train accompanies him for the purpose of establishing, if necessary, a connection between the battalion and the wagons.

During the Russo-Turkish war of 1877-78, in the mountainous country in which the Russian army had to fight, the four-wheeled ammunition wagons, used by them, did not give the results expected from them. They were found too clumsy and unmanageable, and many Russian writers demanded that the type of wagon should be considerably lightened, and that the system of supply of ammunition on the battle field should be much modified. This has been done, and the regulations given above have been largely based on their suggestions. General Zeddeler has written best on the subject, especially with regard to securing the supply on the battle field by means of pack animals. He stated that the ammunition should be carried in light two-wheeled carts, drawn by three horses side by side, and that all the carts of a regiment should be divided into two sections, one of them being always with the regiment and the other in rear of the column with the second line of artillery wagons, which has since been done.

Some German and Russian writers (General Zeddeler among them) think that either two or more pack animals should accompany each battalion wagon, or that the harness of the draught horses should be capable of being used for pack purposes, and that two cases, capable of carrying 1,000 cartridges each, should be provided for each pack animal; the horses taken out of the shafts are for carrrying the ammunition (if there are no special pack animals for this purpose) to a more advanced point than the ammunition carts or wagons can be taken, either singly or in groups, under a non-commissioned officer. Each horse should have a man to lead it, and if a horse is killed, the man with it must remain near it until another horse is brought up, or until the men who have to carry the cartridges to the combatants come up and remove them.

The Russian authorities have apparently acted on the above suggestions, for in the official work on *The Armed Strength of Russia* (p. 258), we read that to convey the ammunition from the wagons to the firing line, "the cartridges are sent forward in bags secured to hooks on the harness of the outside horses (driven four abreast), which are thus temporarily used as pack horses. A horse carries six bags, each containing 24 packets of cartridges."

The German authorities have apparently decided to act in a similar manner, for in the *Revue Militaire de l'Etranger* (No. 572), we find that "the supply of ammunition to the firing line is no longer to be carried out by means of carriers. This method has been recognised as completely inefficacious, and the two leading draught horses of the battalion ammunition wagon will be employed instead. Each horse will carry two boxes of 1,000 rounds each." These horses will only be taken as far as the supports of the firing line, who will carry forward the supply for the men firing.

General Zeddeler recommends that the position of the battalion reserves should, in the first instance, be near the site selected for attending to the wounded men of the battalion, as the constant communication between this spot and the front, would facilitate the supply.

TURKEY.—In 1877-78, the Turks effected their replenishing of ammunition by means of pack animals carrying 2,000 rounds each in 2 zinc-lined boxes, which were led by the men of the battalion right up to the firing line. This method was permissible, from the bad fire of the Russians, who were armed with a very inferior weapon, but it is doubtful whether such a plan could be carried out against a European foe with modern fire tactics. The men themselves carried little but food and ammunition, and so managed to carry 120 to 150 rounds of ammunition (13 to 15 lbs. in weight) each on their persons.

ENGLAND.—Until 1887 the English regulations were quite silent concerning the connection which exists between the engaged troops and the battalion ammunition carts. But this has now been remedied by G.O. for October, 1887, which appears to be supplementary to the G.O. of July, 1878.

Commanding officers of battalions are responsible for the 110 rounds per man in regimental charge, and they must take every opportunity to fill up, as required, from the divisional columns.

Officers commanding the Royal Artillery of divisions and army corps, are responsible to the general officers commanding

divisions, &c., for the 70 rounds per rifle in their ammunition columns. They will fill up from the Ordnance reserves whenever any ammunition has been drawn from their columns by officers commanding battalions, &c.

The position of the divisional and army corps ammunition columns on the line of march is settled by general officers commanding divisions and army corps. Commanding officers of battalions must be kept informed where those columns are.

The position of the regimental reserves is settled by generals of brigades. As a rule, two small-arm ammunition carts and the two mules will follow immediately behind each battalion, and the rest of the small-arm ammunition carts will follow the brigade. (If pack animals only are used, a similar distribution will be made.)

Before going into action, the officer commanding each battalion will select a mounted officer to have charge of the regimental reserve ammunition, and a warrant officer, or staff-sergeant and the pioneers, to be detailed to assist him. This mounted officer will superintend the issue of ammunition from the regimental reserve to the company carriers, and arrange for its conveyance to those engaged in the fighting line.

The captain of every company on service will detail one non-commissioned officer and two privates to act when required as ammunition carriers (if the company is strong, three privates should be detailed). Only men of proved courage, strength, and activity should be selected for this duty, the importance of which cannot be over-rated.

Whenever a general action is anticipated, the whole of the ammunition reserves will be closed up as much as possible, and commanding officers will issue to the men the 10 rounds from the regimental baggage wagons.

The regimental arrangement for filling up the men's pouches immediately before and during an action will be as follows:—

When a battalion is about to attack, the officer commanding will order the issue of extra ammunition, so that, if possible, every man shall carry 100 rounds on his person. This ammunition will be distributed by the carriers, assisted by pioneers and supernumeraries. After the issue the carriers will join the regimental ammunition reserve. If for any reason the regimental ammunition reserve is not close at hand, the fighting and supporting bodies will be furnished with two extra packets per man from the main body. This

will be replaced as soon as possible from the regimental reserve.

The position of the regimental reserves in action will be one small-arm ammunition cart and one mule immediately in rear of each half battalion, and the other small-arm ammunition carts close at hand in rear of the centre.

During the action, communication will be kept up between the carts and the fighting line, partly by means of the mules, and partly by means of one non-commissioned officer and two privates detailed by the captain of each company to act as carriers. These carriers will bring the ammunition from the mule (or from the cart) in bags, and distribute it to the men in the ranks. The bags, which are specially made for the purpose, form part of the equipment of the ammunition cart.

Immediately these extra issues are made, the regimental reserve will be filled up by drawing from the nearest ammunition column. The mounted officer will use his own discretion as to the time when he should send forward the carriers of the companies engaged with two packets for every man of their companies. The loads are not to exceed 40 lbs. to each carrier, and, when advisable, the carriers will be led up to the supporting and fighting lines in action by the warrant officer (or staff-sergeant).

When still more ammunition is required by the fighting line in action, it will be taken forward under command of the mounted officer, the pioneers, band or any men at hand from the main body acting as carriers. The officer will leave his horse before he enters the zone of aimed-fire and proceed with the ammunition to its destination. The carriers will move direct to the companies for which they are destined, according to the rules which govern an advance under fire. On arriving at the fighting line they will distribute the ammunition to the supernumerary rank, and remain with their companies, unless otherwise ordered.

Supernumeraries in the fighting line must ensure that not more than a few rounds are taken to the rear by any efficient soldier who may be sent back; and that all ammunition from the killed and wounded is distributed to the fighting and supporting lines.

The system of carrying ammunition by hand herein provided for is not to excuse every endeavour being made to push forward as far as practicable the reserve ammunition carts, for if they be skilfully and boldly handled by the officer in

charge, they ought, under ordinary circumstances, to get within 1,000 yards of the fighting line in action, and on broken and undulating ground considerably nearer. The immense importance of having a supply of ammunition out of sight of the enemy and yet within easy distance of the fighting line, will justify great risks being incurred in gaining such a position.

It is the duty of the brigade staff to ensure that the emptied regimental ammunition transport are replaced by others from the reserve massed with the brigade column, but to save time all regimental ammunition transport when emptied, must at once proceed to the nearest divisional ammunition column to refill, and then at once return to its position in rear of the troops engaged.

Officers and buglers should, during the fight, keep themselves supplied with at least 40 rounds each to distribute when necessary.

The regulations of July 1878 state that the divisional ammunition column will be placed, during an action, one to two miles in rear of the troops. Its Commander, in taking up position, has to see that his wagons and carts do not obstruct the line of communication, while securing facility for sending his supplies to the front. He has to reconnoitre the roads and paths leading to the front, and keep himself informed of any change in the progress of the action, and of the movements of the troops. A look-out post is to be established. Drivers and others are not to quit their carriages at any time. The troops in front are to be informed of the position of the divisional ammunition column, in order that empty carts and wagons going to the rear for supplies may be correctly directed. When time does not permit of the empty carts and wagons being refilled, filled ones are to be sent forward at once. The second sub-division of the divisional ammunition column is to be drawn on first, leaving the first sub-division intact as long as possible, ready to be sent to the front on an emergency. The Officer commanding a divisional ammunition column is responsible for keeping his supplies as complete as possible from the army corps ammunition columns in rear, and when he sends empty carts and wagons to be replenished they are to be dispatched in suitable numbers and under proper guidance.

The army corps ammunition column is to keep within one day's infantry march of the front or fighting line. No portion of it, except under circumstances of emergency, is to be brought

under fire, since its object is to serve as a connecting link between the divisional ammunition column in front and the field depôt or arsenals in rear, whence its supplies are drawn. If, however, it is considered desirable to send forward any portion of this reserve, the artillery officer commanding it will arrange for the charge and safe custody, as well as for the convenient posting of such detachments. The position of the army corps ammunition column, and of any advanced detachments, must be made known to the commander of the divisional ammunition columns.

Although, as a rule, the empty carts and wagons of the divisional ammunition columns will return to be replenished at the army corps ammunition column, the officer commanding the latter can despatch filled wagons from his column to the front on an emergency. The commander of this column is to keep himself in communication with the head-quarters of the army corps, and to seek orders as to whether he should increase or diminish his distance from the main body.

The English regulations of July 1878, conclude with stating that the foregoing instructions are intended for general guidance only, and can be altered by the officer commanding the forces in the field.

In Ashantee, the ammunition was carried by carriers, and as the enemy's fire was very inefficacious, they were brought up to the firing line, and the ammunition distributed by them to the troops firing, under the guidance of a non-commissioned officer.

In Afghanistan, the necessity for supplying men under fire was never felt.

In the Jowacki campaign, the country was too hilly for the pack animals to follow the troops during an attack, and so they were left behind, and twelve men of each company followed in rear of the skirmishers, carrying, besides their own ammunition, rifles, &c., leather boxes containing 200 rounds each. The total supply for the battalion was, therefore, 19,200 rounds, or about thirty rounds per man, as the battalions were only rather over 600 strong. The men disliked this work extremely, and it was found necessary to relieve them after two miles of heavy and broken country. This method had the serious objection of temporarily withdrawing ninety-six men per battalion, or more than a company. As there was but little firing, the efficacy of this system was not tested.

3. Observations on Supplying Infantry with Ammunition, and Deductions Therefrom.

From the foregoing we see that as far as concerns the supply of infantry ammunition, all the military powers have about the same ideas, and employ the same means, namely, that the men should carry a certain quantity of ammunition, and a further supply should be carried in successive battalion, divisional, and army corps trains, replenished from stationary depôts, and from all that has already been said, it may be seen that the whole subject can be divided under the following six headings :—

1. The number of cartridges to be carried by each man, and how they should be carried.
2. The method of supplying the engaged troops from the battalion supply of ammunition.
3. The manœuvring and placing of these battalion supplies.
4. The replenishing of the battalion supplies from the divisional columns.
5. The replenishing of the divisional columns from the army corps columns.
6. The replenishing of the army corps columns from the army reserves.

(1.) The maximum amount of ammunition expended in any fight, essentially depends on the fire tactics employed, and the fire discipline which the men possess.

Experience has shown that the old method of supplying ammunition to engaged troops, based on the employment of "carriers" is insufficient for troops armed with breech-loaders, as they cannot carry on their work nearer than 500 yards from the enemy. Economy of ammunition is assured by a strict fire discipline (see p. 356), and waste is avoided by a rational "direction of fire" (see p. 355), ammunition being only considered "wasted" when it is uselessly expended. As fire may now be opened at greater distances than formerly, and as an efficacious result is desired at these ranges, it is necessary to use the fire of masses, even with a combined use of different sights, if necessary. Finally, many occasions occur when it is very useful to make a great expenditure of ammunition. Under these conditions, many authorities consider that the number of cartridges carried by the men, and the present methods of supplying them, are totally inadequate to meet these conditions.

In the defence, the problem of the supply of ammunition is comparatively easy, but on the offensive or demonstrative this is not the case. The troops covering the batteries of the attack must be capable of maintaining a musketry fire from the beginning of the fight, until the troops told off for the attack move forward to accomplish their task, that is, during six to eight hours.

In a temporising action, the firing line must not be advanced nearer than 500 or 600 yards to the enemy's main line of defence, so as to prevent its being drawn into a compromising attack before the proper moment, and its principal duty is to prevent the enemy's skirmishers from getting within such a distance (about 1,200 yards) of the attacking artillery, which it is charged with covering during the first phase of the fight, as to be dangerous to it. The firing line can only obtain this result and give their fire an aggressive character, by directing an efficacious fire on the enemy's skirmishers every time they attempt to advance beyond a certain point; but at the distance which still separates the hostile lines, and which will not sensibly diminish until the final attack is delivered, it is only possible to act against skirmishers by directing on them a collective fire of a certain density. Infantry, even if they have the most exact fire discipline, cannot carry out this prolonged duty with only the 70 rounds carried on the men, or with the supplement of 30 rounds per man in the battalion ammunition wagons, and the idea of supplying them, with any large amount of ammunition, over open ground must be looked upon as almost impossible.

The problem to be solved is, how to increase in strong proportions the supply of ammunition carried by each soldier of the attacking troops, without increasing his load during marches and operations. The war of 1870-71 showed that the number of rounds carried by the men was not sufficient for long and sustained actions, and the infantry of both sides had often to stop fighting for want of ammunition, and in nearly every case the failure of ammunition was caused by the loss of connection between the engaged troops and their ammunition wagons or ammunition columns; by the habit of taking off the knapsack (in which some of the ammunition was carried) before attacking, without first taking the ammunition out of it; and by the loss of the officers directing the fire. The want of ammunition will be felt still more in the future, but with troops well trained to fire discipline,

a rational direction of the fire will always act as a palliative to this evil, but, in any case, in order to make use of the ballistic qualities of modern weapons, more cartridges will have to be fired than formerly.

The troops, charged with the preparation of the fight, cannot carry out their duty with only 100 rounds (taking the English system), while the troops told off for the assault, and who are at first kept in rear for the purpose of carrying out the decisive attack later on, will not require to fire even the cartridges carried by the men. This fact must be considered in drawing up rules for the replenishing of ammunition on the battle field, especially when the possibility is admitted of distributing the two *rôles* of preparation and execution between the troops before engaging them in an offensive combat.

The tactics of infantry are now-a-days based on the distribution of troops in depth, because the principal means left to a commander of making his influence felt, under modern conditions of fighting, is to maintain sufficient troops in rear of the firing line to send forward later on at the proper place and at the proper moment. But, as an army consists of units (army corps or divisions) which march separately during the period of operations, and only re-unite for the fight, it will be the commanders of these units who will decide which of their particular troops are to be employed for the preparation and which for the execution of the attack. The troops to be kept for this latter purpose will have sufficient ammunition on the men, and so, if necessary, their battalion wagons *may* be used to supply the troops in front with ammunition before these latter enter into action; but as the troops kept back for carrying out the attack proper, may possibly be called on during the preparation, to assist in it or to ward off a flank counter-attack, or for other duties, it will be better not to make use of their wagons for supplying the firing line, but some of the carts or wagons from the nearest ammunition columns should be advanced to the front, and distributed among the leading battalions as soon as contact with the enemy becomes imminent.* As soon as any battalion cart or wagon is empty, it should go to the nearest ammunition column to be refilled, or better still, as the supply is getting short, word should be sent

* With regard to the position of the divisional ammunition reserves on the line of march to suit the above suggestion, see page 335.

back to this column, which will at once send forward a full wagon or cart to the required spot; by this means each man can be given from 30 to 40 rounds extra, besides those carried in the battalion reserves, and which can be carried in the pockets and haversack and which should be the first to be fired away, together with those which have hitherto been kept in the valise and which are now similarly carried, keeping those in the pouches to the last, as they are most easily got at when the critical and decisive stage of the fight arrive. These supplies should, when possible, be issued to the men before they are sent into action, and during the artillery preparation.

The employment of long range fire, and a want of control over the fire, and of fire discipline, always involve the greatest expenditure, and *vice versâ*.

However, in the future, in wars between European armies, who have all studied now how to make the most of their infantry fire, long range fire is certain to be employed, in combination with the artillery, in the preparation of the attack, in order to overcome the efficacy of the enemy's fire, which alone prevents an assault being given, and to do this the men will require *at least* 120 to 150 rounds each, even when their fire discipline, and the fire tactics employed, are the best.

In savage warfare, or when opposed to badly armed troops, or to troops unskilled in the use of their weapons (which can now-a-days only occur among uncivilized nations), probably half this number combined, with a good fire discipline, is sufficient, because long range fire will not be required, as it will be far better to keep the fire for the shorter ranges*, and the number of troops and the close order tactics used in such operations, do not so easily lend themselves to the sub-division of the troops, viz.: some to prepare the combat with long range fire, and the remainder to decide it. But if the fire discipline is bad, 100 and 120 rounds can be easily expended, as our experience in our small wars has shewn.

Taking only European wars into consideration, it may be laid down as a principle, that considering the almost absolute impossibility of supplying the men with ammunition, when

* On account of the greater efficacy of the fire, the limited quantity of ammunition that can be taken into the field from the difficulty of transporting it, and because savages should be beaten at their best ranges, the shortest ones possible. Savages prevented from attacking by long range fire, never consider themselves beaten.

once under an effective fire (*i.e.*, at ranges under 500 yards), *every soldier should carry as large a supply as possible into action*, due regard being paid to the *rôle* he will have to play.

Recognizing that there is a limit to the burden which it is advisable to impose on a soldier, General Zeddeler boldly recommends a diminution in his general equipment to allow of the number of rounds considered requisite (which may be put down at from 100 to 120 rounds) being carried on the soldier.

A soldier must carry a rifle, bayonet, ammunition, intrenching tool, haversack with food, water, great coat, and a valise in which to carry extra ammunition, food, and the great coat; and it is a very open question whether a greater gain than disadvantage is not to be obtained by carrying the rest of his kit for him. In the course of the war of 1870-71, the Germans often did this, and little, if any disadvantage was found from the increase of baggage wagons, with a good organisation.

However, in the present English equipment, the soldier has 40 cartridges in his pouches, and 30 in his valise, which latter will soon be required; and to get at them the valise must be put on the ground, which the soldier would hardly do during the fight while under fire, or if he did he would leave it behind. This manifest inconvenience has hitherto been overcome by the troops, when about to engage, taking the cartridges out before doing so, and placing them in their pockets.

A soldier's equipment ought logically to be divided into two independent parts, one carrying what is necessary for fighting, and which he should always carry, and the other what is necessary for living, and which may, if necessary, be carried for him;* and further, there ought not to be any cartridges in the valise in such a position that they cannot be *very easily* got at. In the first place the men should have sufficient pouches or bags to carry a supply of 120 to 150 cartridges on their persons, which is the number now considered necessary; and, if any of these cartridges are to be carried in the valise, they should be in small tin boxes placed on each side or on the back of the valise and covered with a flap. Then, if a man wants to replenish his supply, or if he is killed or wounded, he or one of his comrades has only to lift up the flap and the boxes of ammunition can be easily taken out. On the line of march, the Turks in 1877-78, carried 120

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* In their new Infantry equipment the Germans have carried out this principle.

rounds about their persons, but they had no valise or knapsack, and when on the defensive they went into the trenches with their pockets, pouches, &c., full of ammunition, and also carried in their hands, handkerchiefs or articles of clothing filled with cartridges.

It would be of immense advantage if the valise could be readily put on and taken off a man's back without disturbing the rest of his equipment.* Many writers consider that now-a-days, under modern rifle fire, to enable a serious and energetic attack to be carried out, a man must be relieved of every burden possible, and that therefore valises should be removed before an assault, especially after a long march. Every question in war should be considered in the aspect of what men can do when fatigued. This removal of the valises has frequently had to be done in late wars, and experience has shewn that if successful, the men regain their valises; if unsuccessful, they often throw them away, even if they get them back, which is by no means certain. Only the actual troops under fire need remove their valises, if it is decided they are to do so, and these are the troops which, if successful, cannot pursue, from their disorganised condition; and so the fact of their not having their valises would not much affect the question of their subsequent rapid advance.

But, besides fighting, troops have to live and be fed, and as two or three days' food are carried in the valises, most writers do not consider it advisable to allow the men to take them off, in case they may not see them again. A striking example of this was seen in the French retreat from Wörth, in 1870, when the French troops suffered much misery, and became very demoralised for want of food and means of cooking it: they had taken off their knapsacks during the fight, and did not recover them in their hurried retreat. The Germans, in this war, only took off their knapsacks before an attack when they felt, or saw themselves certain of success, or else when they wished to make a rapid march.†

* Such an equipment (invented by the author) was tried at Aldershot, and was approved of and recommended for adoption by the Equipment Committee, but like most other service inventions it seems to have been strangled and buried in some W.O. pigeon hole.

† Thus the XIX. German division deposited their knapsacks on the 7th August, 1870, near Saarbrücken, and they only got them back again on the 23rd August. The XXIX. Brigade took off their packs before crossing the Moselle, just when the situation of the Prussian army at Vionville (16th August) was very critical, and defeat seemed more probable than success. The Russian Kostroma Regiment also took off their packs before attacking the Turks at the first battle of Plevna; but when they were defeated they lost their packs.

Anyhow, the valise being quickly removable, as suggested above, facilitates the cartridges in it being easily got at without all the accoutrements having to be taken off; and in marches and travelling, such a qualification would be invaluable to relieve the men of their loads at the halts.

Further, if the contents of the valise are divided into two distinct parts—a "fighting" and a "personal comfort" part—and the former is made as light as possible, and the ammunition carried in it is so placed as to be readily got at with the aid of a comrade without taking the valise off, then, if the "personal comforts" are carried for the man, the necessity for taking the valise itself off would rarely occur, and should be always avoided, except at halts or when travelling by rail, carriage or boat, when it does not matter.

The pouches in the English service have to be stiff or lined with tin, to prevent the cartridges, made of sheet brass, being injured. If the cartridges were of solid metal this would not have to be the case.

To carry the large supply of ammunition now required in action, *each man should be given as many pockets as possible in his coat and trousers, and might be further supplied with an extra haversack for the purpose, to be worn on the right side.* The additional weight of this haversack, which would only be filled on going into action, need not be considered. Solid-drawn cartridges would reduce any chance of injury from rough usage, to the ammunition in such a case.

One very important point in preventing waste of ammunition by means of fire discipline, and which is only a matter of detail, is to make the cartridges up in packets of five, in order to increase the trouble of opening them, and so to give the officers more control over their men. Small as this point seems to be, it is a very important one.

When a smaller bore rifle is introduced into our service, the ammunition will be lighter, and from this reason alone, one and a-half to twice more of it can be carried. With the introduction of a new rifle, it is intended to adopt a solid-drawn cartridge for it

2 With regard to supplying the engaged troops with ammunition from the battalion supplies, the only means possible of doing so, under a heavy fire, is to have it carried by men, and it may here be remarked that such a method is only applicable when still at a distance from the enemy (*i.e.*, over 500 yards), as no method has yet been devised by which troops can be supplied at any time of the action

during the close combat. The bringing up of ammunition to a firing line by means of pack animals, is only possible when the enemy's fire is ineffective.

There are objections against taking men from the companies actually engaged and sending them backwards and forwards for supplies, when the firing line is near the enemy, because the amount of ammunition they can so bring up is totally inadequate to the wants of the men firing, from their limited power of carrying much weight over heavy ground or enclosed country, and because of the distance they have to go for the ammunition. A single man cannot carry more than 300 to 400 rounds (32 to 43 lbs.); the battalion supply cannot, except under very favourable circumstances, be nearer the firing line than 880 yards, which will take a man half-an-hour to go twice over it, including the time required to get his supply.* This would require eight to ten men to even enable 100 men firing to keep up a slow fire of one round per minute, and eight to ten men is too great a percentage to take away for this purpose at the critical stages of the fight. The Austrians and ourselves propose to use the buglers, drummers and pioneers, for this duty. Further in the English service, officers and the buglers remaining in the firing line are to carry a supply for distribution when necessary.

Then, again, it is very unfair to expect men to cross and recross a fire-swept zone simply carrying ammunition, and it is more than probable that when the men once reach the firing line they will remain there, even if their own rifle has been left behind, for they can get rifles from the dead or wounded.

It ought to be laid down that, as far as possible, no man should ever be sent from the firing line to the rear to find ammunition, for every time a man leaves a place, where the fire has been heavy, to go and seek for ammunition in rear, there is a good chance of his not returning for the day.

All these inconveniences are best met by taking the men for supplying the ammunition from the supports and reserves, and not from the men of the firing line.

These men, after having received their supplies from the battalion carts or wagons, can be sent either to the supports, who will carry them on, or direct to the companies to be supplied according to the orders they have received. These men

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* The English regulations seem to think that 1,000 yards is a fair distance. It would be impossible to keep up a sufficient supply over this distance.

can be renewed as required, and if they are ordered to remain in the firing line without being sent back to the reserve, all the advantages of the Austrian method of supply are thus gained without having its inconveniences. The method of supplying ammunition by means of reinforcing groups from the supports, previously furnished with ammunition, is an excellent alternative method. However, not to exhaust the reserves too soon, when the action commences, men can be taken at first for the work from the companies engaged, and when reinforcements are required later on, then the men from the supports and reserves can be utilized for supplying ammunition as above.

The Russian plan of having a distinguishing flag for each company is a very good one to ensure facility of supply.

The argument that the men when once in the firing line will not give up the cartridges they have, can be met by discipline, by giving the men more cartridges than they can conveniently hold while making use of their rifles, by making them carry these cartridges in their helmets, turned upside down, like buckets, and by training them to realize the value of mutual co-operation. Again, the utility of distributing, before the fight, ammunition taken from the battalion and divisional supplies (see p. 322) to each man in all the companies to be engaged, cannot be too strongly insisted on. Any increase of load at this moment, in the shape of ammunition, is not of much account, as it diminishes as the fight progresses, and *the best method of all for ensuring to a soldier a sufficient supply of ammunition for the fight, is to give him, from the first, the full supply considered necessary, to carry on his person*; but the strictest fire discipline must be maintained not to let him waste a round of it.

Supplying engaged troops by means of the ammunition carried on the persons of the troops in rear is an excellent substitute for supplying from wagons when these are too far away. But it should only be resorted to in case of necessity, as the troops from whom the ammunition is taken may require it before they can get a fresh supply themselves.

One plan might be tried to increase the supply of ammunition that can be brought up by carriers, which is to have one or more light stretchers, with slings, for passing over the shoulders, attached to the handles, carried on the ammunition wagons or carts. Two men can carry more ammunition by such means than they can in bags. Such a stretcher might be fitted with a small wheel, so as to allow of its being used as

a hand-barrow by one man, but it should always be capable of being used as a stretcher in case the wheel was broken. These appliances would only be supplementary to the canvas bags already used for the ammunition supply service, because men with bags would often be able to bring up cartridges in safety, when men with stretchers or barrows could not.*

A German officer has suggested that *these bags should be made of a red coloured material* so that they can be easily seen if dropped, and so would be picked up by any men or troops moving to the front. This seems a good suggestion.

It is an important principle to lay down that an engaged body of men has the right to supply itself at the nearest supply of ammunition, when circumstances require it.

It is not necessary to wait until the last moment, in an important engagement, to replace the cartridges expended, both on account of the probable insufficiency of the number of those which the men carry, and in order to avoid the uneasiness produced in the men's minds by the exhaustion of their ammunition. The thing is to keep up the men's supply while it is possible, so as to let them enter the decisive part of the action, when supply is impossible, with as full pouches as possible, and to ensure this *the first rounds expended must invariably be replaced at once.* This can be done, as they are generally fired off at some distance from the enemy, and there should be an absence of that confusion which of necessity arises later on in the fight as the hostile troops approach one another. Company leaders should be held strictly responsible that this is seen to at any favourable opportunity before the further forward movement takes place.

The ammunition of the dead and wounded should be collected and fully made use of during an action.

In prolonged contests, or to defend a definite position, small ammunition depôts should be established near the firing line in conveniently selected positions. These ammunition depôts would be drawn from the battalion and divisional supplies, which, thus lightened, would go and bring, at the beginning of the action, fresh supplies from the divisional or other columns.

With regard to the transport of ammunition from the carts or wagons to the engaged troops by means of pack animals,

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* The method proposed by Major Geddes, in a paper entitled "Manual Transport," to be found in Vol. XXIV. of the *Journal of the Royal United Service Institution*, might be experimented on for this purpose.

in a four-horsed wagon, two horses might be used thus, if they had a suitable harness, as two horses are enough for the empty wagon, and they can get another pair of horses from the divisional column to bring back the loaded wagon, thus leaving two horses in the divisional column for the empty wagon left there. In carts drawn by two horses, one horse can be used for this purpose. Special pack animals, such as donkeys, ponies, or mules (two per wagon or one per cart) could be taken if thought necessary; but such a use of pack animals is doubtful under a well-directed fire, because a pack animal forms a fairly large mark, and cannot be so easily kept under cover as a man. But when the enemy is still some little distance off, ammunition could be thus taken up to the supports at least. In savage warfare, however, pack animals can be taken up to the firing line. The Turks took their pack animals up to the firing line, but then the Russian fire was very bad.

When pack animals can be used for carrying ammunition to the firing line, they would of course be employed in preference to carriers, as they can carry more than men can, and do not take away so many men from the battalion for the ammunition supply service.

(3) The manœuvring and placing of the battalion ammunition supplies is a very important point.

All nations give as drivers to the battalion ammunition carts or wagons, infantry men taken from the battalion to which their carts or wagons are told off. Experience has shewn that in war, the proper manœuvring of the infantry battalion ammunition supplies can only be assured by drivers taken from the troops which they are to accompany. A trooper of the military train, or of the artillery, attached to an infantry corps to drive its ammunition carts or wagons would, in the field, find many difficulties. He is unknown to all around him, and cannot have the same interest in the corps as one of its own men. Therefore infantry should be charged with the manœuvring of its own fighting train, the maintenance of its carts or wagons, and the preservation of its ammunition. This does not apply to the divisional and army corps ammunition columns.

The drivers of the battalion carts or wagons ought to be given as extensive an instruction as possible, so as to make them capable of carrying out, and of making their wagons do everything that can be expected of them. Then, these carts or wagons, well horsed and well driven by the men

of the battalion will, far from being "impedimenta," as they are sometimes considered, thus become a precious instrument, doubling the value of the troops, who will be certain of being well provided.

An intelligent non-commissioned officer, capable of initiative, is indispensable for the proper guidance of the battalion carts or wagons, for choosing the situations for them, for the distribution of the ammunition, for the replenishing of the empty wagons, &c. Hence the non-commissioned officer should be practised in this work in peace time, and not be only told off for it in time of war. The German plan of making the battalion adjutant responsible for the battalion wagons is a questionable one, as this officer is required for many other duties in the field.

It is also very important that a certain number of men should be trained in each battalion to looking after ammunition; these should be the men who act as the loaders and unloaders of the wagons, and give the ammunition to the men who are to supply the cartridges on the battle field. One or two men should be told off permanently to each wagon; these men should accompany the wagon in all its movements, and when it has to move rapidly may get on it, and while going prepare the bags and ammunition for distribution.

This service of the battalion fighting train ought to be organised in peace time, as this is the only means of ensuring that the duty will be properly carried out at the moment of battle, which is the one object to which all military institutions ought to converge.

On the line of march, the battalion carts or wagons ought to follow, wholly or in part, immediately in rear of their respective battalions, or they should be grouped together in rear of the brigade; but no battalion ought ever to think of moving or going into action without an ammunition cart or wagon, any more than a battery of artillery would think of doing so without its wagons.

As the position of the battalion carts or wagons on the battle-field cannot be laid down in an absolute manner beforehand, a great latitude should be allowed in this respect, but the regulations of the various Continental armies all show the necessity of not having the wagons more than 880 to 1,100 yards from the firing line, and of sheltering them as much as possible from the enemy's fire. The first thing to be laid down is, that every cart or wagon should follow its battalion in all circumstances, and get as near to it as possible. It

may be stated that, in the majority of cases, the cart or wagon should move with the battalion reserve. The introduction of volleys at long ranges will considerably affect the *rôle* of this reserve, for, as some of the companies advance towards the enemy, this reserve will, if possible, be established in favourable positions, and cover the advance by volleys at long ranges: as this will cause a considerable consumption of ammunition, the place of the cart or wagon should be near it, either between it and the support, or on one of its flanks, or in rear, but always near it.

When the reserve itself takes a direct part in the action, the cart or wagon may, or may not, be sent to the regimental or brigade reserve, and may even, in very exceptional cases, be brought into the firing line itself, such as when a battalion is established in a defensive position, or when a position or advanced point has been captured and must be held at all costs against counter-attacks, &c.

The position of the carts or wagons ought to be indicated both by day and night by very apparent signals, such as a coloured flag by day, and a coloured lantern by night, placed at a distance of 150 to 200 yards to one side, so as not to draw on the carts or wagons the enemy's fire. The flags and lanterns should be of the same colour.

It is very important that all the ammunition wagons of the battalion and divisional supplies should be the same, so as to be interchangeable. This does not apply so much to the army corps ammunition columns, which have more time to load and unload. If the wagons for infantry and artillery are of the same pattern, they should be coloured differently, or have broad bands of distinctive colouring to distinguish them. Also flags and lamps of different colours should indicate their different positions. Similarly, all artillery wagons should be the same. None of these interchangeable wagons should be marked by any corps distinctions.

The measures adopted by all foreign powers, of establishing a constant connection between the wagons and the commanders of the different tactical units by means of mounted orderlies, is a very excellent one. General Zeddeler's proposal that the battalion ammunition supplies should be kept near the dressing places of the wounded, is also a good one, as the constant flow of wounded men to this point would at once point out the direction of the battalion ammunition supplies to the men sent to seek it.

Every battalion cart or wagon should supply the demands

of any corps which may ask for ammunition, on the one condition that this corps is engaged.

The capacity and fittings to be given to the packets of cartridges and to the men's pouches, the method adopted for placing the cartridges in the valise, the best form to be chosen for the ammunition boxes, and their stowage in the carts or wagons, exercise a great influence,—one, on the use of the rifle, and the other on the good and rapid working of the supply of ammunition. But these matters of detail cannot be gone into here.

The ammunition boxes in the English service are much too heavy for one man to carry. The cartridges of rolled sheet brass used in our service compel them to be kept in heavy solid boxes to prevent them getting damaged. Abroad, solid metal cartridges are used, which enables them to be kept in canvas bags with handles, by which they can be carried, if necessary, direct to the men. This would be an immense improvement in our service, it would do away with the unserviceable boxes we are now compelled to use, and a solid cartridge is said to give better shooting.

(4). With regard to the replenishing of the battalion ammunition supplies from the divisional ammunition columns, one of the battalion carts or wagons should be emptied before the others are touched, so that directly it is empty, it may go to the divisional column to be filled, and return before the others are empty. A battalion ammunition cart or wagon ought never to remain when once empty, but should immediately go and replenish itself at the divisional column. The loading of a wagon requires nearly a quarter of an hour with a working party of three men, which, with the time of going and returning, makes its absence long enough, so that a wagon once empty, should be taken to the divisional infantry ammunition column, and be re-filled; or if the carts or wagons are interchangeable, the teams should at once, in cases of urgency, be taken out and harnessed to a full wagon. In every case, the replenishing or changing of the wagon should always be superintended by a non-commissioned officer.

In order to facilitate the replenishing of the battalion supplies, groups of wagons should be sent by the commander of the divisional column to various points in rear of the engaged troops. The commander of these groups should seek out the battalion supplies and inform the non-commissioned officer in charge of them of their whereabouts:

also, if the carts or wagons are interchangeable, the carts or wagons of the divisional column when they get into position should be parked, and the teams of some of them should be taken out to leave them ready to be rapidly taken away.

In order to diminish any chances of delay in the carts or wagons going to and returning from the divisional columns, it is indispensable that the connection of the battalion carts or wagons with the troops they supply, as well as with the divisional ammunition columns which supply it, be kept up by means of mounted men or signals. It is the only means of keeping the wagons from profitlessly wandering to the right or left, looking for the reserves. This should be part of the duty of the officers commanding the divisional columns who are not so occupied as the men with the battalion supplies.

Some writers think that it is dangerous to send any wagons or carts to the rear, as they may not return. Instead of doing so, they advocate that when a battalion wagon or cart is nearly empty, a demand should be sent to the rear for a full one. This method seems by far the best, as it certainly, in any case, would cause a saving of time. If this principle were adopted, it could be laid down as a standard rule that no man, cart, or wagon is to be sent to the rear, from under fire, to obtain fresh ammunition.

After an action, if there are several partially emptied battalion wagons or carts, as many as possible of them should be filled up from the others, and the remainder only sent, under an officer or non-commissioned officer, to be re-filled from the divisional supplies.

The importance of selecting a good position for the divisional ammunition columns is well illustrated by the retreat of the French right at Gravelotte, in 1870, merely for want of ammunition. If the French had had any fresh supply forthcoming, they would probably have held their position until their reserves could have come up and intervened, and perhaps the fortunes of the day might have been different. Two days before this battle, after the Mars-la-Tour-Vionville fight, the French also retreated, although undefeated, "to replenish their supplies."

Also we read in the German official account of the Franco-German war that "The want of ammunition was felt on a large scale at first during the battle of Mars-la-Tour by the infantry of the 3rd Army Corps; then by the corps of the 1st Army engaged on the 18th August, to the east of the defile of Gravelotte; on the 28th November by the detachments of

the 10th Army Corps which occupied Beaune-le-Rolande; and in many other battles. Similar inconveniences were specially felt by the 1st Bavarian Army Corps during its combats in the basin of the Eure and on the Loire. In the majority of the numerous combats delivered in these countries, the battalions were almost always obliged to limit their action for want of cartridges, or to go to the rear in order to replenish their ammunition. This want of cartridges was always due to the rupture of the communications between the combatant battalions and their ammunition wagons, or the ammunition columns." Hence we see the importance of entrusting such columns to good and experienced officers.

Some writers have considered that the infantry should have charge of its own divisional and army corps ammunition supplies, instead of the artillery, but this would only unnecessarily create further commands. The artillery can perfectly well carry out the duty, and are more accustomed to the care and preservation of ammunition than infantry. Infantry is the main fighting arm, and it should leave the supply duties to the auxiliary arms.

With regard to the position of the divisional ammunition columns on the line of march, on the defensive the supply arrangements are comparatively easy to carry out: but on the offensive let us consider the case of two English divisions (14 battalions) marching on the same road in column of route*, and coming into action, with the ammunition columns in the rear. The first brigade of the leading division will act as the advance guard, and will be the first troops to deploy and expend their ammunition. They will be about two miles ahead of the main body.

The second brigade of the leading division, forming the head of the main body, will probably prolong the line of the first brigade, and will be about four miles from the divisional ammunition columns.

Thus allowing a rate of march of 3 miles an hour, on account of firing being heard, the first brigade will have been 2 hours and the second $1\frac{1}{3}$ hours in action, before the divisional columns can arrive to replenish the battalion carts. This is supposing the roads open and free to movement. The

* This is supposing the worst case, as when pursuing troops in column of route are checked by a rear guard. Against an enemy in a known position, the attacking troops would probably form up beforehand for battle, and move over the last three or four miles in lines of battalion quarter columns, if the nature of the country permitted it, in which case the divisional ammunition columns could be brought quite close up to the leading troops.

roads may be obstructed, the divisional columns will be looking for shelter, and taking up their positions, and so the above times would in reality be increased.

Thus some, or even all, of the ammunition carts of the divisional supplies of the leading infantry division should march in rear of the leading brigade, close up to the front. This will not prevent the rear division arriving in time to perform its part as a reserve of troops, because the increase of the length of a column by introducing even 21 such carts—*i.e.*, 3 per battalion of the leading division—is only 315 yards (allowing 15 yards to a cart), or about the length of a battalion in column of fours. The artillery divisional ammunition supply may march in rear, as all batteries of artillery carry enough ammunition with them to fight for some hours, and their distant position from the enemy allows of their being comparatively easily supplied, which is not the case with the infantry, who by this time have approached the enemy so near as to be practically out of reach of fresh supplies, unless they are brought up by the supports or other reinforcing troops.

(5) The rules for replenishing the divisional columns from the army corps columns are practically the same as those given above. The commander of the army corps column should inform the divisional ammunition columns of its whereabouts, and establish connection with them by means of orderlies or signals.

(6) The army corps ammunition columns are replenished from the stationary depôts forming the army reserve and which are created at fresh points as the army advances. The supply is brought to them from the depôts by the general transport wagons of the army. The army ammunition reserves are in charge of the Ordnance Department.

Résumé.

Thus we see from the foregoing the different means available to make the supply of ammunition on the battle field as perfect as possible.

The principal points are as follows:—

1. The personal necessaries in a soldier's valise should be reduced to a minimum, while the number of cartridges which he carries should be increased to *at least* 100 rounds, and an extra haversack and ample pockets (in his coat and trousers) should be given him, to enable him to do this, and to receive a further supply of 50 or more rounds on entering into action.

2. The supplying of ammunition should, as much as

possible, precede the attack, because the service can only be exceptionally carried out during a close fight. Every pause in the fight should be fully made use of from the very outset to replenish the supply of the men firing, and the ammunition on the dead and wounded should always be made use of.

3. The load of the foot soldier should be lightened to the extreme limit possible, but it should be absolutely forbidden to put the valise on the ground previous to an attack, unless the cartridges have been first taken from them. The cartridges in the pouches to be used last.

4. There should be a universal pattern infantry ammunition cart or wagon for the battalions and divisional ammunition columns, so that they may be interchangeable.

5. If they are of the same nature, the infantry carts or wagons should either be of a different pattern or shape, or be painted a different colour to those of the artillery (or have bands of different bright colours on them) to distinguish them, so as to facilitate the supply.

6. The battalion and divisional ammunition carts or wagons need not have the name of the corps or column painted on them, so that there need not be any necessity to return them to their original owners after an action.

7. Flags and lamps of different colors are required, to show the positions of the battalion carts or wagons, and of the infantry and artillery sections of the ammunition columns. These flags in an action should be placed at some distance to one side of the supply centres that they mark.

8. The cartridges should be solid-drawn, and made up in packets of five; they can then be kept in *red coloured* canvas bags with handles, each containing 250 rounds, or 50 packets of five each. Wooden, tin or zinc-lined boxes may hold four of such bags each or 1,000 rounds, and two boxes would form a convenient load for pack transport; the cover of the boxes should be very easily opened, without the assistance of instruments.

9. Special *red coloured* canvas bags should be carried on every battalion wagon or cart, and on a certain number of men per company told off to enable the ammunition supply service to be carried out. Supplementary stretchers, capable of conversion into hand barrows might also be carried on the wagons or carts for facilitating the distribution of ammunition.

10. In each battalion a non-commissioned officer should be trained for the ammunition service, also some men of each company to act as drivers of the wagons, and others to carry

out the duty of carriers, loaders, &c., and thus to create a true battalion fighting train.

11. The supply from the battalion carts or wagons to the combatants to be carried out as much as possible from the rear by men taken from the supports and reserves. Officers and buglers may also carry some ammunition for distribution.

12. In special cases engaged troops may draw on the personal supply of the troops in rear of them.

13. Constant connection to be established between the battalion and divisional columns, by mounted men trained to this duty.

14. When it is intended to make a determined resistance, small depôts of ammunition should be made in rear of the fighting lines.

15. Immediate replenishing of every empty cart or wagon by the divisional and army corps ammunition columns, either by an exchange of ammunition, or, if circumstances require it, by an exchange of wagons or carts; these latter to be brought up to the point required.

16. To enable the supply to be carried out by pack animals, on favorable occasions, either special pack animals should be provided for the purpose, or some of the draught horses should be given pack saddles (or riding saddles strong enough to be used for pack purposes); a pair of canvas saddle-bags would then be required for each pack animal.

17. During the marches which precede an imminent action, the divisional column ought to hand over one or two wagons, or an equivalent number of carts, to each battalion destined to take part in the preparation of the fight. The commander will base his orders for the distribution of these wagons or carts, on the distribution of the *rôles* of preparation and execution among the attacking troops. The advance guard should also have a certain proportion of extra ammunition carts or wagons attached to them.

18. Any *engaged* troops should be allowed to draw on the battalion supplies of any battalion for ammunition. A signed requisition should not be required, but a statement as to the amount drawn, the hour, and by whom drawn, should be made out by the non-commissioned officer in charge, while the ammunition is being served out, to act as a check both on the amount of ammunition left in the battalion reserves and upon the corps who have fired away so much.

Thus we see that the problems of how to bring up supplies of ammunition into the firing line *in the attack*, and how to

distribute them to the men actually engaged, are two of the most difficult and at the same time two of the most important problems to be solved in modern warfare.

On the defensive, on the other hand, it is not a difficult matter to organise arrangements which shall ensure that a stationary line of defence will, within certain limits, never run short of ammunition, because one of the first cares of the defence, when a position is to be energetically held, would be to create ammunition depôts close in the rear of each tactical unit, by emptying the battalion ammunition carts or wagons and then having them replenished.

Seeing how difficult it is to supply the firing lines with fresh ammunition in the attack, the troops should be well supplied before commencing the engagement, and it is for this reason that most ammunition supply regulations now direct that before an action the battalion supply of ammunition, in whole or in part, should be distributed to the men. A greater supply is usually given to the men when on the defensive than in the attack, as they can excavate small receptacles in the trenches for the ammunition, which has not now to be carried.

Since therefore, it is so difficult to supply the assaulting troops of the attack with fresh ammunition in the short and decisive ranges, such troops should reserve their supply to the utmost, and not commence firing until within effective range. Their advance should be prepared, covered, and rendered feasible by a well-sustained artillery fire, and also, when possible, by fire from lines of infantry at long ranges, disposed in suitable positions behind cover or hasty entrenchments, and which can then be kept supplied with fresh ammunition as in the defence.

In defending and attacking intrenched camps, when the fight lasts several days, the supply of fresh ammunition can be effected at night, as was done in and around Metz in 1870.

As it is easier *to supply ammunition than men* to an army in the field, a large supply of ammunition with a good supply organisation may make up for a superiority in numbers with a defective method of supply on the part of the enemy. Hence we see the necessity for perfecting the arrangements for the supply of ammunition in every way possible. It cannot be too strongly insisted on, that troops should be frequently practised in peace time at being supplied with ammunition during an attack, "for this service can only be ensured by the aid of men perfectly accustomed to duties of this kind."

Before concluding this chapter we must refer to the question of using carts or wagons for carrying the battalion and divisional ammunition reserves. England and Russia make use of two-wheeled carts, while Germany, France and Austria-Hungary use wagons with limbers, &c., very like those used by artillery. Such wagons *may* get mixed up with the artillery ones unless distinguished by colour, but these colours may be easily obliterated by the rough usage and exposure of a campaign, and being special wagons require special manufacture, and cannot be used for any other purpose.

England and Russia* have both come to the conclusion that two-wheeled carts will answer every purpose. They require more careful loading than wagons, but they cannot be mistaken for the artillery ammunition wagons, and are more easily replaced by local means. They must be strongly made, so as to be capable of being taken across country.

But as regards the relative advantages of one or two large wagons or several small ones or carts, a writer in the *Revue Militaire de l'Etranger* has made the following remarks, which are well worthy of notice. After having discussed the Austrian regulations for the supply of rifle ammunition during a combat, he concludes thus: "The company wagons are therefore only at the disposal of the company commander, when the company is detached, otherwise they remain under the command of the battalion or regimental commander. By this means it is intended to avoid the disorder which is caused by an increase in the number of wagons. It is even considered injudicious to allow each battalion to have control over their own wagons. It is by no means always possible, even for light wagons or carts, to go across all kinds of country. In Galicia, notably, the next probable battle field of Austria, is covered with deep and marshy depressions which can only be crossed by wagons at certain bridges and fords; in other districts the slopes are so impracticable that wheeled vehicles must follow the roads. Thus in a mass of circumstances, compulsory points of passage will be found, at which would occur, during an action, if each battalion had control over its own wagons or carts, an accumulation of ammunition columns, each marching on their own account to find the reserve of their battalions. This accumulation will be all the more

* The Russians in 1880 experimented with different kinds of ammunition carts and wagons, and came to the conclusion that two-wheeled carts were the best as regards lightness, mobility, and capability of surmounting obstacles.

dangerous should it occur at the moment when the roads ought to be free for the movements of the artillery.

If the wagons are united in columns by regiments, especially if they are grouped under the command of an officer, order will be more easily established; but on the other hand, this column of 12 wagons will not be able to profit by the small accidents of the ground which would be sufficient to hide a fewer number of large battalion wagons. If all the wagons of the same brigade are collected in a single group, they would fail in their object, for the column thus formed would only be a kind of first echelon of the divisional park. The regimental grouping appears, therefore, to be the most advantageous, and would have to be most frequently adopted, in spite of the disadvantage pointed out above."

"The name of 'company' given to the new ammunition wagons does not at all indicate the permanent attachment of a wagon to each company of infantry, which may, therefore, be a cause of embarrassment and disorder."

These remarks apply also to the carts used in the English and Russian services. Further, a large battalion wagon will not take up so much space on the line of march as two lighter wagons or carts. On the other hand it must be remembered that both England and Russia carry on wars in many different countries, where no disadvantage can occur from using light carts, from the small number of troops engaged, and from the heavy nature of a roadless theatre. But what has been said above probably accounts for the French preference for employing few large battalion wagons in place of a greater number of small ones. However, Germany has followed the example of Russia, Austria, and England, in the use of company instead of battalion ammunition wagons.

With regard to the form of cart, it is objectionable to use one, as we do, that is of a special character, and cannot be used for any other purpose. The pattern of Maltese cart, to be seen in the Royal Carriage Department in Woolwich Arsenal, and which is known as Mark III., is much better suited for the purpose than the present small arm ammunition cart. It has a platform 5 ft. 9 in. long by 4 ft. broad, and weighs 6 cwt. 1 qr. 14 lbs., while the present small arm ammunition cart weighs 8½ cwt. when empty, and 20 cwt. when full, showing a saving of over 2 cwt. per cart, when the cart is used, even when including a tarpaulin to cover the ammunition with. This Maltese cart can be easily drawn by one or two horses, and has the great advantage that when in camp, the ammunition can

be taken out and the cart used for bringing food from the Commissariat stores, water, wood, forage, &c., or for any other battalion administrative purposes. It carries some wooden cross pieces, which can be attached to the shafts, to enable it to be used for hand draught. This cart is a very simple one, and can be made and repaired anywhere, and if necessary in difficult country, 3 horses could be attached to it abreast, or in unicorn fashion.*

In the English service it would be far better to have 4 such carts per battalion or 1 per double company, and as each cart can carry 9,600 rounds (the weight of which including boxes is 1,268 lbs.), this would raise the battalion ammunition supply to 40 rounds per man.

From Table XIX., on p. 300 and the foot-note attached to it, we see that, on the battle-field, English troops have a smaller total supply of rifle ammunition than any other army. The Author thinks that by reducing the contents of the valise, each infantry soldier could carry 100 rounds; engineers 50 rounds; and non-commissioned officers, only 20 rounds, as these latter should really look after the men and rarely fire themselves, (see Chapter XV.) The battalion carts and the divisional and army corps ammunition columns should each carry 40 rounds per man for units at war strength. This would give a nominal total of 180 rounds per rifle on the battle-field, and a real one of over 200 rounds per rifle, if the non-effectives are not counted. The ammunition columns should further be divided into distinct sections for the infantry and for the divisional and corps artillery. The want of this latter sub-division is a great defect in our service.

In conclusion, it is necessary to point out *the importance and even absolute necessity of practising any system adopted of distribution of extra ammunition in peace time as a regular exercise until it becomes as systematic a habit as that of any other routine work in the field*, "for this duty can only be assured by means of a *personnel* familiar with manœuvres of this kind." This is a *thing* absolutely neglected in the English service. It requires a special training for men to collect ammunition and carry it in bags to the nearest group leaders for distribution to the men. Besides this the men should be most carefully taught the danger of running short of ammunition, and that in every case they should keep a small reserve of ammunition for sudden surprises and counter attacks have frequently to be met.

* A similar cart has been recommended by Captain G. Harris. See article on "Our Ammunition Columns," in Vol. XXXI. of *The Journal of the Royal United Service Institution*, 1887.

CHAPTER XIV.

UNCONTROLLED AND CONTROLLED FIRE.

There are two methods of allowing men to fire:—

1. *Uncontrolled* or *independent fire*,* in which each man fires at his own convenience and judgment as to range and objective.

2. *Controlled* or *collective fire*,† in which the independency of the fire of the individual men is controlled and directed according to the will of their commander.

Controlled fire can only be executed when the men are collected into organised tactical groups or massed bodies, which are then used as "units of fire," because, under an enemy's fire, one leader alone cannot control a large number of individual men, although he can a smaller number of organised groups each under a recognised subordinate leader.

Uncontrolled individual fire is naturally independent fire, and anything *independent* should be avoided as much as possible in war, as it is not likely, from being uncontrolled, to work for the mutual good of the whole. As General Skobeleff said in one of his famous orders in the Geok-Tepe campaign "In the art of affording mutual action has always lain and will always lie the secret of victory;" and again, before the battle of Lovtcha in 1877 he said, "Do not forget the sacred duty among all, to give help at all costs, whoever your neighbours may be."

Both uncontrolled and controlled fire have their theoretical advantages and disadvantages, but practically, it has been found that uncontrolled fire is very pernicious, and is conducive to great waste of ammunition, and what is far worse, to great loss of moral force in the men using it. The advantages and disadvantages of the two kinds of fire are as follows:—

Advantages of Uncontrolled Fire.

1. It allows the soldier the greatest independence to fire when and at what he likes. (A doubtful advantage when the good of the whole should always be thought of.)

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* The word "individual" is purposely not used here, as "individual firing" does not necessarily mean "uncontrolled firing" as "independent firing" does.

† *Collectiveness* of fire necessitates *control*.

2. It gives a quicker and more continuous fire than controlled fire, which must have pauses for instructions and orders.

3. In certain situations, as in cases of extreme danger and excitement, it applies itself better to the moral state of the soldier, because it does not require a continued attention to the commands of the leaders, as a controlled fire does.

Disadvantages of Uncontrolled Fire.

1. When once begun, especially when near the enemy, it can neither be regulated nor moderated, and degenerates into a rapid, wild and inaccurate fire.

2. From not being able either to regulate or moderate it, it conduces to an excessive consumption, and therefore waste, of ammunition, and to disorder.

3. There is no check as to what the men are firing at, or if they are using the proper sights, or even that they are aiming.

4. It soon produces in front of stationary men such a thick smoke that the object fired at is completely hidden—a disadvantage which does not show itself to the same degree in controlled fire.

5. It presents to a commander such great difficulties in controlling both the fire and the men, that it almost renders any required offensive advance impossible which is not already in operation when the uncontrolled fire begins.*

6. It has a very bad effect on the moral spirit of the men, as it tends to increase the excitement, by causing an impression that danger is near, and as the ammunition decreases, so does the courage of the men engaged, unless fresh troops or sufficient ammunition are forthcoming at this moment.

7. The fire cannot be readily directed from one object to another, or the sights altered. This is very important when the enemy's cavalry are to be feared.

8. It is the least terrifying kind of fire to an enemy, especially at the longer ranges.

9. It is almost always frontal and unconcentrated.

10. Its efficacious use at all ranges requires a higher state of discipline and training among the troops than is usually possible.

* The only way of controlling independent firing to any extent is by means of shrill whistles, and by accustoming men in peace time to cease firing when they hear them.

Generally, once an uncontrolled fire is allowed to begin, especially if the enemy is near at hand and the excitement great, it will continue unchecked until the last round has been spent, from the natural tendency or inclination of the men to fire as hard as they can, for the purpose of keeping their spirits up, so as to enable them to stand the intense mental strain of the moment. In very heavy firing neither bugle, nor voice can be heard to put a stop to it, though foreign writers assert that a very shrill whistle can be used for this purpose with effect. Therefore this uncontrolled fire should be used as rarely as possible, and to practice it at drill is considered, by some writers, not only needless but positively harmful. At short ranges, in close contact with the enemy, any controlled fire will of itself degenerate into a rapid uncontrolled fire, the men will no longer pay any attention to orders for control, and the pauses will disappear. There is no need to order independent or uncontrolled fire in such cases, for no prohibition will prevent it.

Advantages of Controlled Fire.

1. Not a round of ammunition can be fired without orders.
2. It gives the means of regulating the intensity of the fire by the rapidity with which the words of command are given.
3. It gives the means of seeing that all the rifles are directed on the named spot, and that the men use the sights ordered.
4. The fire can be stopped to allow the smoke to clear off, when it gets too thick.
5. The pauses in the fire can be as long as the commander pleases.
6. The pauses enable orders to be passed down the line as to what is to be fired at, the sights to be used, when to cease fire, when to advance, &c., and has a quieting effect upon the men when they are tending to get out of hand.
7. It permits the commander to control the effects of the fire, according to the results he sees produced.
8. It enables the fire to be stopped at will, on an order, which permits of an immediate offensive advance from the defensive or halt.
9. The fire can be rapidly directed from one object to another, such as to oppose an unexpected charge of cavalry.
10. It allows a change of elevation to be made at any instant.

11. It allows of a use of combined sights when means of ascertaining the distance accurately are wanting.

12. It allows of seeing whether the men are aiming or firing wildly.

13. It gives better results at all ranges, because if men are left to themselves, they always fire at a prominent object only; a controlled fire can be directed successively against all parts of the enemy's line.

14. It has a sudden and therefore offensive character.

15. It has a very terrifying effect on the enemy, when the range is known and the fire is well delivered, as it suddenly pours in at once a searching concentrated mass of bullets at one spot, while in uncontrolled fire the fire cannot be concentrated and so the bullets fall here and there.

16. It shakes the moral force of the enemy by the sudden loss of a number of men.

17. It requires less discipline and training on the part of the men to get good results.

Although the following remark of General Brialmont was made with reference to formations, yet it can be equally well applied to the relative moral effects of controlled and uncontrolled firing. "Men in column are more powerfully impressed by losses than men in line, especially if they halt to fire. This is because the men killed or wounded in a deep mass are seen by a greater number of soldiers than the same number of killed and wounded men in a thin line. This difference of moral effect is especially felt when infantry is exposed to artillery fire." General Brialmont might also have added "or to a collective infantry fire." A given number of men falling at the same instant will produce a greater demoralising effect on the remainder of the men than an equal number of men falling here and there, singly or in twos and threes.

Disadvantages of Controlled Fire.

1. The greatest rapidity of fire cannot be obtained from it, from its requiring pauses for instructions to be given, but this rapidity of fire is rarely wanted until the closest ranges have been reached, while it soon causes such a thick cloud of smoke that the object cannot be seen, which must decrease the efficacy of the fire and cause a great waste of ammunition. This extreme rapidity of fire only takes place when it becomes

uncontrolled from the proximity of the enemy, and when the objective therefore is near enough to be hit by being in the dangerous zone of the rifle when the latter is placed parallel to, or better still, slightly inclined towards the ground, which is the only rule for aiming that can be followed in a thick smoke.

2. It is unsuitable to certain demoralising situations, as for example, the very close approach of an enemy, which keenly impresses a soldier, and makes him inattentive to the voice of his commander.

Controlled firing is only possible when the troops have sufficient calmness and presence of mind to listen to orders. In European warfare this is rarely possible at the short ranges, except on the defensive, when the firing line is sheltered by natural obstacles or by entrenchments.

From the above examination of the properties of controlled and uncontrolled firing, we find that a controlled fire unites the greatest number of advantages and ought therefore to be preferred for all cases for which it is suitable. Therefore uncontrolled fire should only be *tolerated* when a controlled fire is not possible, viz., when in very close proximity to an enemy.

Whatever the disadvantages of controlled fire may be, they will be amply compensated for by the control maintained over the men, by the certainty that ammunition will not be wasted, that the sights will be properly adjusted, and that the fire is directed where required.

"Fire can be executed in two ways: by command, or independently. Experiments have been made with both alternately. In war, it is very important not to waste ammunition uselessly; the fire ought to cease immediately that the objective disappears, or when it offers too small a surface; the officers ought therefore to be masters of it, and, in this point of view, fire by command has the preference."—(C.C.J.)

"Controlled fire preserves us from the thoughtless firing of a soldier who believes he has acquitted his conscience by having fired off all his cartridges without considering the *nil* results which arise from such a badly organised fire."—(Okounef.)

"Controlled fire renders a commander capable of carrying forward his men at the exact moment he judges opportune; he holds them better in hand so to say; controlled fire produces on the enemy an overwhelming moral effect, because it presents to his mind a feeling of order and consequently of an

organised force; it prevents waste of ammunition in a futile firing; in a word, when properly applied, it should absolutely prevent the success of an offensive movement on the part of the enemy."—(Girard.)

"In an uncontrolled fire soldiers do not adjust their sights properly; they fire quickly, the smoke prevents them from seeing before them, the noise of the firing drowns the voices of the leaders, and even the sound of bugles, and thus the men continue to uselessly waste their cartridges."—(D'Azémar.)

The Italian regulations say, "The maximum effect of fire can only be obtained so long as the fire can be concentrated on the point which seems to be the most important, and in the shortest time possible." This can only be done by means of a fire perfectly under control.

Every cartridge may be life or death to a man, so he should never waste a round. He should never fire where he cannot see anything to fire at, but he may fire at smoke and ought to do so, to intimidate the firer there, and so demoralise him, and make him fire wildly, while he may even hit him. *Victory is not decided by mere loss of numbers only, but it is gained by that side which can first intimidate or demoralise its opponent.*

"The Germans have very strong ideas on the character which ought to be given to fire in battle. They do not hold with a slow, continuous, progressive fire; in their opinion, the action of fire should in all circumstances be sudden, unexpected, and powerful in order to present an offensive character. Thus, this action can only make itself felt during successive very short intervals, separated by a pause, during which order and calmness are re-established, smoke is allowed to dissipate, and orders relative to the objectives to be fired at, the elevations to be used, are given.* The effects of suddenness and the power of the fire obtained by means of such an intermittent fire apply equally well to a decisive or to a demonstrative action (such as true or false, or principal or secondary attacks); a continuous fire has not the same effect. Also, an intermittent fire appears destined to be retained in the future, from necessity, because it is the only kind possible and admissible

* It is very important that men should be trained to pass orders along the line, in case of necessity, for at least a length of 50 yards. Such a transmission of orders would have a good steadying effect on men who have a tendency to become excited. Instances have occurred when men, under fire, have been made to go through the manual exercise in order to steady them after having got rather out of hand.

with magazine rifles, which are likely to become the armament of infantry."

Further, an intermittent fire allows of efficaciously maintaining fire discipline, and of checking the troops who have a tendency to prematurely expend their ammunition and to get out of hand. *The economy and the regulated expenditure of cartridges is, and will always remain, a vital question in the tactics of modern fire.*

The regular pauses of controlled firing should be obtained by the fire of large units ceasing, as a whole, for a sufficient time. If the pauses are only obtained by small groups, one of these will finish before another, and perhaps begin again, so that no real pause in the firing line will occur for orders to be transmitted, or to allow the smoke to dissipate, and it will have all the appearance to the enemy of a continuous fire, losing thereby the moral effect of suddenness.

We have said that uncontrolled fire should be reserved for very close ranges, in which exact aiming is not so essential, or indeed is impossible, from the smoke, which always hangs about a heavy independent fire, but which only requires that the rifle should be fired parallel to or rather inclined towards the ground. To decide on this range we must consider the ballistic qualities of the rifle.

Now, as a general rule, when once within the effective range of the enemy's fire and until the assault takes place, the men will lie down to fire, so as to offer the smallest mark possible, and besides, when lying down, inequalities of the ground may be used which are valueless to men in other positions. It is astonishing what a very small irregularity of ground hides a lying down man from view. The lying-down position also gives longer dangerous zones. (See p. 64).

When a man fires lying down, his rifle will be about one foot from the ground. Now, first taking the case where the men will not aim in their excitement, when the Martini-Henry rifle is fired exactly parallel to the ground (*i.e.* with no elevation), at a height of one foot above it, the bullet will first touch the ground at a distance of about 125 yards from the muzzle. But by the time the soldier has come to within 400 yards of the enemy his shoulder is tender, he is very excited, and his moral force is highly strained and he is anxious to fire as quickly as possible. All these causes tend to make him fire very high, while bringing the rifle up to the shoulder tends still further to throw the muzzle up, and experience only shows this to be the case. Thus practically

under the conditions of war we should find that a man lying down and firing from his shoulder will make his fire sweep over the first 400 yards in front of him, counting ricochets, as of course, much of such fire will be ricochets, and will be almost equally effective when directed against the thick firing line of the enemy.

Now, taking the case of men who will aim, in Part I., it was shewn that if a man, with a Martini-Henry rifle, used the 400 yards elevation with a fine foresight, or the 300 yards elevation with a full foresight, and aimed always at the enemy's feet he would always hit an upright man at any distance up to 400 yards.

Therefore, up to 400 yards, or as near as we can get to the enemy, we should employ controlled fire which enables us to assume the offensive readily, to control the fire, and to hold the men in hand, while it has a high moral effect on one's own men, and a bad one, especially if well directed, on the enemy. Having got as close as possible, say 400 yards, or even nearer, the strain becomes very great on the men, and we cannot prevent a rapid uncontrolled fire. Any hope of forcing the men forward now against their instincts will be hopeless. Now comes a period of the most rapid fire. This will be the critical moment of the fight; soon a desire or panic to rush forwards or backwards, will seize the men; if the enemy is demoralised and consequently relaxes his fire, or retires, then the men will rush forward to victory, but if the enemy is not shaken, and still pours in a deadly steady fire, then the men must recoil before it with terrible slaughter. A rapid short range fire is not an accurate individual fire, *but depends for its efficacy on the grazing power of the fire of the mass of troops.* The French musketry regulations say that, "a rapid fire, executed at from 220 to 330 yards, only owes its efficacy to the flatness of the trajectories. One is forcibly led to use it when the moment of the final crisis arrives. Its duration will be very short, and this crisis will be followed by the solution." A rapid fire is most fatiguing to the men, and cannot possibly be maintained long. (See Chapter VII.)

Hitherto we have only considered the soldier as pitted against an enemy as well armed as himself, and equally skilled in the use of the weapon. Against an inferior fire or enemy, a controlled fire will be just as effective at these short ranges, and may be feasible to maintain, because as the men will not be so excited or demoralised by previous losses, a greater control over the fire will be possible. But at all times, we must

remember that so many causes tend to make uncontrolled fire inaccurate (viz., hasty firing, individual faulty appreciation of distance, badly adjusted sights, and thus waste of ammunition, smoke, and the tendency that such a fire has to weaken the moral force of the men), that we ought to try and keep it for the shortest ranges only. As has been pointed out before, the longer the range, the more necessary is it to use collective firing, so as to increase the chance of hitting, and also the longer the range, the larger, if possible, should be the number of men firing at the same mark. Controlled fire allows a deliberate aim to be taken, and a deliberate and far more accurate estimation of range; it allows of watching the men adjust their sights, and of controlling the expenditure of ammunition; there is much less smoke with it than in uncontrolled firing, while this smoke clears away quicker; it tends to increase the moral force of the men, besides which, it does not form a continuous line of smoke, continually showing one's position to the enemy. Thus in every case, controlled firing is best, and should be maintained until the enemy is so close as to render it impossible to be carried out, from the excitement and tension of the men's minds, and then a rapid uncontrolled fire must be permitted,—in fact it cannot be stopped, for the men will take to it of their own accord. The worse the enemy, and the better one's own troops are, the less will this distance be, and *vice versâ*.

Thus controlled firing is essential, because it is of the greatest importance that a commander should not cease for a single instant, if possible, to have his men perfectly under his hand, if he wishes for success. This can only be done by controlled firing, as an uncontrolled fire, unless in exceptional cases, reduces the power of control over the men to a minimum.

"Thus the education of the soldier ought to be directed towards a severe fire discipline, so that a commander may, in the middle of a combat, obtain every advantage from the rifle, and be able to pass suddenly from the defensive to the offensive, when the opportune moment, always short in war, presents itself."

CHAPTER XV.

FIRE DISCIPLINE AND THE CONTROL AND DIRECTION OF FIRE.—FIRE UNITS OR GROUPS.

Now, since infantry in action acts almost exclusively by fire, it can only obtain a superiority over an enemy by means of a superiority of fire. This superiority is gained, other things being equal, either by a numerical superiority, by a greater efficacy of fire, or by a greater rapidity of fire, combined in each case with a great consumption of ammunition, and suitable formations of small depth, to prevent *excessive* losses from the enemy's fire. Considering opponents equally well armed, numerical superiority is limited by the space available for the troops; greater efficacy of fire, by the training received in peace time; the consumption of ammunition in action, by the amount carried by the soldier, to which may be added the extra quantity which may be issued to him before entry into action; and the rapidity of fire, by the loss of accuracy which it entails when pushed to extremes, the available supply of ammunition, and the facility of replenishing it. With regard to the formation, the greatest amount of fire, from a given front, is obtained from troops in line, in close order, two deep; but long lines in such a formation are not manageable, and would suffer great losses under modern fire, and hence opened out lines in single rank are what are now-a-days used, at all events in the earlier stages of the fight, until the enemy has been demoralised and the efficacy of his fire so reduced as to admit of denser and deeper formations.

Infantry fire, in order to be efficacious, must be directed by the troops in extended order on comparatively few objectives, at a time, so that it may be of a collective nature; in a word, grouping of skirmishers and concentration of fire is the modern idea of fighting. The great range of modern rifles allows of the concentration on a single object, not only of the fire of the troops immediately opposite it, but also of the neighbouring troops; and the grouping of these troops, and placing them under the direct control of their officers and others, facilitates the "direction of the fire," and permits of the needful concentration of fire, which is necessary to obtain the greatest effect. Besides, it is the officers alone

who are capable of deciding when the opportune moment arrives to open fire; they alone can judge of the results to be expected, and estimate whether the consumption of ammunition will be remunerative or not, or even advisable from the facility and means available *at the spot* for replenishing it.

The French regulations express themselves in the following manner on the general principles for conducting fire in action:—

"Fire is the preponderating element in battle. Its action must not be abandoned to individual initiative, or else it will degenerate into a useless fusilade, cause a waste of ammunition, and accordingly expose the troops to the danger of finding themselves practically disarmed at the decisive moment.

"*The duty of controlling the fire falls on the commanders of the companies forming the fighting line, and on the officers employed in this line.*

"The captain determines the objects to be fired on, the nature of the fire, the fractions of troops to be thrown into the line during the whole period of preparation. He orders the general distribution according to the object to be attained, reinforces the line according to the necessities of the fight, and, while leaving to the officers under his orders the necessary initiative for the execution of the duty which he has assigned to them, he watches that the fire does not deviate from the direction which he has assigned to it, and tries to control it up to the last moment.

"The sectional commanders (according to the orders they have received) indicate to the men the sights to be used, point out the objective to be aimed at, the number of cartridges to be fired, and regulate the intensity and duration of the fire.

"The duty of the commanders of the smaller units (*i.e.* groups), is to watch that the orders are carried out concerning the sights to be used, the direction of the fire, the pauses and re-opening of the fire, or in a word, to assure the execution of the orders given.

"The control of fire requires calmness, decision, skill in estimating distances, tactical judgment to appreciate the importance of the different objectives that present themselves, as well as a complete knowledge of the properties of the ground, the ballistic qualities of the rifle, and of the effects it can produce."

The German regulations say with regard to the control of fire in action:—"In action, the utilisation of the rifles, as long

as control of fire exists, belongs to the leaders. A rational employment of the fire is one of the essential guarantees of success. The necessary conditions to obtain it, are—calmness, tactical judgment, skill in estimating distances, gift of observation, correct appreciation of the ground, and knowledge of the ballistic properties of the weapon."

The first principle in action is to concentrate the fire on the important points, and to put in action the greatest number of rifles possible, so as to obtain the desired result in the shortest time. To do this, the following questions would, during the period of preparation for the assault, pass through an officer's mind in about the order given. "When shall I open fire, and what number of rounds must I expend? What number of men must I place in the firing line? What is the exact line on the ground on which I must extend them? What named objectives must I specify to them to fire on? What is the range of these objectives, and what sights must the men use? What kind of fire must be used? What intensity should the fire have? What attitude should the men fire in? How can I best observe the results of the fire?"

Having determined on an answer to each of these questions, an officer has still to ask himself during the period of execution, when the advance to the assault takes place,—"Shall I let my men fire while in movement? What number of rounds am I to let the men fire at the halts after each rush forward? When shall I order the bayonets to be fixed?" Besides these questions, an officer must also frequently ask himself—"How is my expended ammunition to be replenished?"

The direction of the fire consequently means (1) the determination of the moment of opening fire,* the estimation of the number of cartridges to be used to attain a definite result, and the consideration whether the existing phase of the fight, as well as the available supply of ammunition, and the facility of replenishing it, will justify such a consumption; (2) the determination of the force required in the firing line, in order that the number of cartridges deemed necessary may be fired in the desired time; (3) the choice of the ground to be taken up by the men; (4) the selection and allotment, amongst the body of troops firing, of the objects to be fired on; (5) the determination of the range and choice of sights

* This is more with reference to the period before the actual offensive attack takes place.

to be used; (6) the determination of the kind of fire to be used; (7) the intensity of the fire to be kept up; (8) the choice of the attitude to be taken up by the men firing; (9) the observation of the results obtained; (10) the advisability of allowing men to fire while in movement or not; (11) the number of rounds to be fired at the temporary halts after each rush or bound in advance; (12) the choice of the moment when bayonets should be fixed; and (13) finally, the supply of fresh ammunition and means of providing it during the various phases of the fight.

The control of the firing consists in the carrying out of the above orders, that is, in ordering the elevation, the objective to fire at, the number of rounds to be fired, and the kind of fire to be employed, in seeing these orders obeyed, and in watching that the men take careful aim, with the required elevation, and on the desired object.

The direction and control of fire are included under the name of *fire tactics*.

Fire discipline, or *the execution of the fire*, may be defined as nothing but the unhesitating habit, developed in the men by instruction and training, of commencing, or ceasing, or relaxing the fire, or of concentrating it upon a defined object, all in obedience to the deliberate will of the commander. *No firing should ever be permitted without orders, and it should cease immediately the command is given for it to cease.*

The Italian regulations say that "In order to obtain the maximum effect from infantry fire, the indispensable conditions are:—A rigorous fire discipline on the part of the troops who execute it, and an intelligent direction on the part of the leaders who command it."

Up till lately, in Continental armies, the company* of 200 to 250 men was considered as the "unit of fire," and, therefore, most of the duties of directing the fire belonged to the commanders of the companies in the firing line, while the duty of the sectional commanders and non-commissioned officers was to *control* the fire of the men, by taking care that they aimed at the object indicated, with the sight ordered, that they carefully observed the proper in-

* A German company of three "zuge" consists of 250 men in war time, and, in action, has a "zug" or one-third of the men extended in the firing line, the remainder being in support. The Austrian, Italian, and French companies consist of 250 men, divided into four sections each. These companies, after the first few days campaigning, will only muster about 200 men each, even before an action takes place.

tervals of periodic firing, that they expended only the numbers of rounds ordered, and that they did so in the time fixed. The sectional commanders were the agents of the company commander in all that related to the control of fire, and abroad, where the sections are further sub-divided into groups, each under a leader for control and guidance, the sectional commanders were assisted in this duty by the group leaders.

But lately in the German and other armies this duty of the fire direction has been also thrown on to the sectional commanders, from the difficulty that the company commanders have in commanding and directing such a large body of men under fire as a company of 200 to 250 men. *The direction of the firing* is thus confided to the officers and section leaders in the firing line, the actual *control of the firing* is left to the group-leaders, while *fire discipline* is required of the men.

The complete maintenance of such a sub-division of duties is only possible at some distance (about 400 yards and over) from the enemy, before such serious losses have occurred as must entail an *irregular* mixing of groups and sections on the troops in rear being sent forward.* The Germans try to avoid this *irregular* mixing as long as possible, which must loosen the control, and when it must take place they make the *small* groups and sections in the firing line close in on themselves, as required, as the losses occur, and then reinforce them by bringing up complete groups or other units into the gaps so left. But even when this is not possible, or has not been done, there is an immense value in having a number of men, accustomed to lead in a firing line in order to try and guide and direct the confusion and so to lessen it. Men must be taught in peace practices to attach themselves to the nearest commander, and to obey the rank, and not merely the person only, so as to accustom them to obey strange leaders when under them. Two things are necessary for this, (1) that each soldier should have the strongest conviction of the uselessness of independent fire at all ranges over 400 yards, and of the efficacy of a collective fire; and (2) discipline among the men—the key note of every

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* Much confusion of ideas has arisen from an improper use of the words "mixing of units." The words "irregular mixing" are purposely made use of here. The Author has, on p. 427, endeavoured to define the expression "mixing of units" more clearly, and to put a limit to its use. A regular mixture of units, by placing them side by side, cannot have the same disadvantages as an irregular mixing of them, causing them to be all jumbled up anyhow together.

success in war. All the above remarks can be applied perfectly well to the English organization, except the remarks concerning group-leaders, as we have not yet introduced the group system in our attack formation. It is to be hoped that, in the future, the non-commissioned officers of the English army will be taught and allowed to lead and control the action and fire of the men in both close and extended order.

The sections of Continental companies, when mobilized for war, vary from 60 to 80 men in strength, and these are sub-divided into groups of from 8 to 16 men each, each under a non-commissioned officer or old soldier,* and which are given a bond by being used for administrative purposes, and for the sub-division of duties in barracks, camp and quarters. When the non-commissioned officers have been well taught, and consequently looked up to and respected by the men, it must have a great influence in action, especially in the final confusion of the fight. At the shorter ranges, groups are soon broken up by the dissolving power of the modern breech-loader, and get mixed up by the fresh arrivals of troops from the rear. Now comes to the front the effect of any discipline and peace instruction that the men have had to place themselves under the nearest leader, even if a non-commissioned officer, in order that their fire may be given the greatest effect by being used collectively. The following extract is taken from the well-known pamphlet, *The Frontal Attack of Infantry*:—"The importance of non-commissioned officers depends less on their command of appointed groups than on the influence which their position, experience and matured character insures them over the skirmishers in their vicinity. They are the mainstay of the officer in the exercise of his influence over the skirmishing line. They should be the first to follow him, and so draw the men on by their example, and in an emergency they must be able to take his place. For this it is necessary in peace time to make every endeavour to develop their intelligence for tactical relations† and country, and to elevate them both mentally and morally.

* The German group consists of eight men only; the "zug," a third of a company, contains 10 of such groups, under the officers and non-commissioned officers of the "zug." The French and Austrian groups consist of 14 men in war time, and four groups go to a section, or 16 groups to a company.

† Tactics cannot be separated from fire. Modern tactics is the art of obtaining the greatest development of fire with the least loss to oneself.

"It is, however, the company officers who are of the greatest importance for the maximum development of the whole strength of the skirmishing fight. They must have the greatest impulse for independent activity, so as to seize immediately each opportunity for action. They should have sound tactical judgment, so as to survey the situation quickly, and make dispositions accordingly, so as to join in the fight properly, either by an opportune support of another detachment or by taking advantage of any weakness displayed by the enemy. Lastly, they should have a knowledge of country, so as to be able even in action to detect the slightest advantage offered by it.

"Training men to independent action may tempt them to get away from control sooner than they should, for greater independence, and so destroy all order and power of guidance of the whole, especially at a time when the extent of ground covered by the extended troops, and the tax made on them by the impressions of the action, have enormously increased the difficulties of the command."

Continental practice does not, however, agree with another extract from the same work, namely,— "The system of working men by groups in the firing line in peace time is very pernicious, as it makes men look to the group-leaders for everything; the men get accustomed to be led, and do not make any use of their intelligence." From what has been said, this leading of the men in the firing line is just what is wanted to obtain mutual action, and it requires the fullest intelligence of the man to allow himself to be thus led. The independent action of men in the firing line, at ranges over 400 yards, cannot be too strongly deprecated.

The Germans, who have perhaps studied this question most deeply, are unanimous in declaring that fire discipline must be principally obtained by the moral ascendancy of the leaders over their men; but they own, that even with this ascendancy the control of the fire can only be maintained up to a certain point.

The most perfect supervision will lead to no result unless it is supplemented by the most stringent fire discipline, and it cannot be too strongly impressed that *it is only when every soldier has been well practised in this fire discipline that the full effect of modern rifles can be obtained.*

When direction and control are no longer exercised, fire must become irregular, and therefore, *as a principle*, the company and sectional commanders must endeavour to preserve

the control of the fire as long as possible, even in the shortest ranges.

"To keep their men in hand ought therefore to be the constant and principal preoccupation of every company officer in all peace exercises; they ought to try and maintain the direction of the fire as long as possible, even when their men have entered into the zone of short ranges. If they know how to do this, if they succeed in time of peace in inculcating into their men this fixed conviction of 'not to fire a single shot without the approval of the nearest officer,' then they may hope to obtain in the field such a fire discipline as will be fruitful of great results."

Now let us deal in detail with the first twelve different parts of the duty of direction, mentioned on pp. 355 and 356. The thirteenth heading, on the supply of ammunition, has been fully dealt with in Chapter XIII. and will not be referred to again.

1. The Distance at which Fire should be Opened and the Number of Cartridges to be Used to Attain a Definite Object.

No definite rules can be laid down for such an estimation, but it is greatly governed by the cover available, the existing phase of the fight, the target offered by the enemy, the available supply of ammunition, and the facility of replacing it, all of which must be well considered, in order to come to a conclusion whether such a consumption is justified. This is much more important for the attack than the defence, as the means of supplying men constantly moving towards an enemy over fire-swept ground are far harder than those of supplying stationary men under cover. Naturally, the first rule is to approach the enemy as near as possible, so as to open the most efficacious fire possible.

"Commanders of companies in the fighting line ought, on principle, to order commence firing, not when the infantry fire of the enemy becomes dangerous, but when the line has got to such a distance from the enemy that its fire is effective.* In advancing to the attack, and as soon as the artillery preparation is at an end, they should endeavour to push their

* The effective range at any moment depends on the accuracy with which this range is known, and the size and exposed height of the objective. The general opinion, however, is that men should be allowed to fire a little early in the fight, while advancing, to keep the offensive spirit up, and not to demand too much from them.

firing line within effective range of the enemy, that is in principle (theoretically) up to 400 yards, then immediately to reinforce the line in each company, and then to commence firing.

"Nevertheless, the most determined advocates of this close fire allow that the troops of the first line can only fulfil the requirement of getting within effective range of the enemy, when the ground on which they move is particularly favourable. Should it not be so, fire must be opened before arriving at 400 yards, that is to say at some distance between 800 and 400 yards.

"In the German army it is held that when on the defensive fire should be opened sooner than on the offensive, as a rule at 800 yards. This divergence of practice is justified by the facts that, for the defensive, the ranges are more accurately known, and may even be marked, the supply of ammunition is easier, the men are under cover and can fire from a rest.

"It is needless to say that if, before arriving at 800 yards distance, the enemy should offer a favourable mark, a fire of masses would be directed upon it.

"All the commanders engaged, but particularly those commanding units not yet within effective range of the enemy,* should always try to estimate the amount of ammunition which must be expended to attain a definite object, and consider whether the immediate situation of the fight, the local available supply of ammunition, and the facility for replenishing it, will justify the required expenditure.

"In the case of a false attack, or a delaying action, it may be absolutely necessary to execute a vigorous fusilade, or to keep up a more or less lively fire at distances more or less considerable, although there may be little hope of inflicting serious loss. The object to be gained, in these cases, is to deceive the enemy, and to keep him tied to the spot; the fire should therefore be regulated accordingly, but the commander should always take account of the amount of ammunition required for the action which he is ordered to carry out, and arrange for a proper supply of cartridges to replace the expenditure.

"These considerations of supply, therefore, exercise great influence in fixing the moment when the order to commence firing should be given. It is quite certain that a body of troops supplied with an unlimited amount of ammunition

* For example, troops in the first line, while the artillery preparation is going on, or troops in second line, or troops sent to execute a false attack or a delaying action.

would scarcely need to think of waste, and might open fire at much greater distances than those which have been laid down for ordinary practice. Moreover, it is not to be forgotten that, in an attack, opening fire at too great distances diminishes the offensive power of troops, and gives a protracted character to the attack. It may be added that the moral force of the troops is injured by seeing that their fire is ineffective whilst that of their adversary increases in power.

"Commanders of companies judge the expenditure of ammunition and estimate the number of rifles to be brought into play by certain very simple data," obtained by calculation from the results gained by peace experiments on the effect of modern rifle fire at different ranges on different formations, and on the different positions of standing, kneeling and lying down.

Beyond the limits of accurate independent fire, certainty of effect is only to be obtained by the collective fire of a great number of rifles on the same object. In this case only can we count on a certain percentage of hits, which will depend on the height, breadth and depth of the object.

For practical purposes, Tables IX. and XIV. (pp. 145, 170), show sufficiently well the relative proportion of losses, between the line and column, lying down and standing, and gives sufficient data for ascertaining the desirability or otherwise of opening fire.

The following simple data, obtained by calculation from Table XIV., are given by Major Von Metzier:—

"When the object represents a line of men standing up, and is divided into spaces equal to the breadth of a man, one hundred shots give at 440 yards twenty hits, at 770 yards ten hits, and at 1,100 yards five hits.

"Against a kneeling enemy, at medium and long ranges, the results would be less by a half, and if he were lying down they would be one-fourth only. Against an extended line the results would be a half, third, &c., according to the density of the line; against a company column the losses up to 770 yards would be more considerable,* and beyond that distance would even be doubled."

All the numbers given in the above statements can only be considered as approximative.

To get a good effect against objects over 770 yards requires a large expenditure of ammunition, and if it is to be quickly attained, as should be invariably done when possible, a proportionately large number of men must be employed. Under

* See General Brialmont's remarks on p. 171.

certain circumstances, however, a good effect against large objects, such as batteries and closed bodies of troops, may be obtained up to 1,300 yards.

The data given in Tables IX. and XI. show the approximate connection between the number of hits and the ammunition consumed.

As an inefficacious fire weakens the moral force of the men delivering it, and raises that of the enemy, therefore before opening fire the company commander ought always to consider if the consumption of cartridges thought necessary to attain a certain object is in harmony with the result hoped for, and is justified by the situation of the fight and the supply of ammunition available. If the company commander sees no result from his fire he should at once stop it, and wait for a more favourable opportunity for re-opening fire.

With the question of the amount of ammunition required for a definite object, the question of the distance of the object is intimately connected. We see from the above-mentioned tables that *the longer the range, the greater is the amount of ammunition required to be expended to gain the same result.* Thus, this fact combined with the supply of ammunition available and the *rôle* that the particular body of troops has to play, will decide whether the fire may be opened at once, or reserved for a closer range. The closer the enemy is approached the harder it will be to break off the fight, should this be required to be done.

The French regulations say: "The distances at which fire may be opened depend on the greater or less facility of correcting the fire, on the form of the ground, on the vulnerability of the objectives, and on their tactical importance.

"The only result of firing at a distant objective is to demoralise a body of men, to retard their entry into action, and thus to give greater chances of success later on; the occupation of an important point, such as a bridge, a *debouché* which an enemy must pass through, &c., can be rendered difficult by it; but it rarely produces decisive results, the only results aimed at in a decisive action. Thus its usage demands a sound and carefully weighed appreciation of the situation, and it must not be left to the initiative of leaders of all grades. As a rule it is the battalion and company leaders who will determine the object, the time, and the duration of such a long range fire.

"It is especially at the short distances that it is necessary to have available a great number of cartridges and rifles, in

order to have a decisive superiority at the time when the fire produces the surest and most powerful effects.

"The preparation of the attack at long distances belongs to the artillery, and it is only exceptionally that infantry can join in it.

"A premature opening of fire in the fighting line only prolongs the fight, and leads, therefore, to a weakening of the ammunition supply and of the moral energy of the assailants.

"On the offensive, in open ground, the firing line ought never, as a rule, to open fire beyond 800 yards. Intersected and close ground allows it to approach to short distances without firing.

"On the defensive, occasions will be found, more often than on the offensive, of making use of an efficacious fire even up to 1,300 yards, on objects of large dimensions, principally on artillery and cavalry.

"This distant fire of the defence will also compel the assailing troops to take open order sooner, and perhaps cause them to make a greater consumption of ammunition at longer ranges than they should."

But long range fire should never be attempted unless the range is known within sufficient limits, and care must be taken that its use does not involve a want of ammunition at the decisive moment, and special care must therefore be given to replacing the ammunition as it is expended.

"It should always be borne in mind that beyond 800 mètres (880 yards) a serious efficacy can only be obtained by a great individual consumption of ammunition if there is not time to put a sufficient number of rifles into action. Hence, the fire at all these ranges, except in exceptionally favorable circumstances, should not be ordered by captains of companies. But when the order is given to fire on any stated objective, the total number of cartridges required to obtain a useful effect should be unhesitatingly used, for experience has shewn that an inefficacious fire seriously influences in a dangerous manner the spirit of the troops firing, and acts morally to the profit of the enemy.

"Up to 800 mètres objectives of full height can be fired on with good results, but beyond 400 mètres, any efficacy on objectives of small height is only to be obtained by a large consumption of ammunition.

"Fire beyond 800 mètres is an exception that can only be justified by the vulnerability of the enemy's formation in front, height and depth; it can be used up to 1,200 mètres on

special objectives such as batteries, columns, massed formations, etc."—(*Bulletin de la Réunion des Officiers*, 1885).

Having considered the range and the amount of ammunition that will have to be expended in attaining the object in view, the company commander will have further to consider whether the existing phase of the fight, or the ammunition that he has, will justify the expenditure.

If the combat is in real earnest, as in a decisive battle, then every round must be retained by the attack for the shorter and decisive ranges. Hardly anything will justify a single round being expended at any range beyond the nearest that can be got to, though, from the moral encouragement that returning fire gives the men advancing under fire, a few rounds, under the most severe control, may be fired during the advance to the decisive ranges.

Then, again, in such a fight, it is impossible to supply ammunition when the real advance has once begun.

In temporising actions, or false attacks, fire may be opened at longer ranges, as the attack will not be pushed home, which enables it to be broken off at any moment, and the supply of ammunition is facilitated.

If there is no artillery, or if there is an inferiority in this arm, infantry will have to prepare its own attack, in which case a much larger amount of ammunition will have to be expended, and a proportionately larger supply will have to be provided for. 120 rounds, fired only at the rate of one a minute, will be expended in two hours.

The amount of ammunition to be expended cannot be formulated by any rules, but experience alone can form a guide to this consideration, and this experience is entirely wanting in the English service.

After all, we see that there are no exact rules that can be given with regard to estimating the exact amount of ammunition to be expended to attain a definite object. All that can be said is, that if a decisive result is required, the ammunition must be saved for the shortest range possible. The shorter the range, the men being in hand, the more effective the fire. The more important the objective fired at is, in a tactical sense, the greater is the number of cartridges that should be poured on it.

If we do not wish to close with the enemy, then get to the nearest distance which will still allow us to retire unimpeded, so as to get the greatest efficacy possible to injure him as much as possible. To break an enemy's strength in every

way, however small, is the object of war. The sum of several small effective efforts will, in the end, amount to a large result.

2. Determination of the Force Required.

Having formed some idea as to the amount of ammunition to be expended, the next thing is the determination of the force required in the firing line, in order that the number of cartridges deemed necessary may be expended in the desired time.

It may be laid down that when an earnest attack is contemplated, it should be carried out in the shortest time possible, and with the greatest determination. *Clearness of design and energy in execution is, therefore, essential for success.* A long, drawn out, hesitating attack is fatal to the offensive spirit and to victory. *The first condition of all is to gain a superiority of fire. This is the price of victory.*

The French regulations say:—"The number of men to be employed depends on the tactical object in view, on the number of cartridges necessary to obtain a good efficacy, and on the time available for the execution of the fire.

"A slow fire, left to individual men, has no useful effect, while it offers the great inconvenience of delaying a forward movement.

"The supports ought to be brought up into the firing line as soon as it is really necessary to act by fire. It is essential for effect, to produce from the beginning a powerful concentration of fire on the enemy's front."

As fire is the preponderating element in battle, the supports should be moved up to the weak extended skirmishing lines as soon as fire is to be seriously opened; it is essential that a powerful combination of fire should be opened on the enemy from the very first, as soon as an effective range is reached.

Rapidity of action is best obtained by the suddenness of fire, which is one of the principal conditions of its efficacy. The moral influence of a material result gained is the greater as this result is obtained in a shorter time.

As the moral effect of sudden and rapid losses is so great, *it is best to expend the required ammunition as quickly as possible, by employing the greatest number of rifles that can be conveniently used at one time on the same objective.*

"The useful effect of a fire depends on its accuracy and

rapidity, but this result is better sought in the medium and long ranges by means of the accuracy of the fire, and the number of men made to fire, rather than by too great a rapidity of fire."

It should be remembered by the leaders that *the moral effect of fire upon troops is the greater the more it is concentrated, not only as to place but also as to time.* A whole company firing five rounds per man on a given objective, will produce a greater impression than a fourth of the company firing twenty rounds per man.

The Italian regulations say:—"Being given a tactical objective to destroy by fire, the effective to be employed will depend on the number of bullets necessary to obtain the required result, and on the time that it is to be effected in. Thus, for example, if one is obliged to expend a considerable number of cartridges in a relatively short time, which usually happens when a long range fire is to be directed on troops in movement or against a battery coming into action, or if one wishes to ascertain the range by observing the strike of the bullets, it is necessary to rapidly employ a considerable force, in order to be able to concentrate on the objective a great mass of projectiles in a very short time. In these cases it is necessary to make a body of men to fire, of strength at least equal to a company (200 men). For these purposes, Table IX., p. 145, must be carried in the memory, at least approximately."

"On the offensive, moral and material superiority consist, at the present day, in not being afraid to expend the necessary number of men, and in getting so near to the enemy as to be able to make the effect of our fire felt very quickly, and thus to inflict rapidly on the enemy the amount of loss required to be decisive of success." (*Moderne Feuertaktik*). Nevertheless, it is evident from many Continental writings, that voices are now being raised in favour of the maxim that "the assailant ought to open fire as soon as the fire of the defensive party begins to be effective." The same author adds "In perfectly level country one can rarely approach within 800 yards of the enemy without covering the advance by fire. The losses would become in fact so heavy that the fighting line would be insufficient to ensure a superiority of fire. Even if it were possible to arrive within 400 yards of the enemy's position, as has often been recommended, it cannot be denied that the men being without cover would, at this range, be in a very critical position."

A French writer, in the *Journal des Sciences Militaires* (1880), says, that when pitted against the breech-loader, "The greatest superiority should be tried to be secured by deploying great masses of skirmishers. To restrict the fire, by only extending the fewest possible skirmishers at first, only tend to place us, from the beginning, in a state of inferiority as compared with an enemy acting according to other principles. The German principle is to give a great density to the line of skirmishers placing the men almost elbow to elbow. Lines of skirmishers should be more or less strong from the beginning; weak lines partake rather of the character of an advanced guard fight to keep off small hostile detachments, but they are not suitable in battles, properly so called, because they only obtain results very slowly, and therefore they will, after all, have to be reinforced when the fire-fight begins. Dense lines of skirmishers will be preferable in open ground, but in enclosed ground, on the contrary, where sometimes unforeseen events occur, a thinner line of skirmishers would be used, so as to leave more in reserve. As the defence usually fires at known distances, and with more coolness, from its being sheltered, it is less likely to waste its ammunition, and hence it can open fire sooner, while its fire need not be so intermittent as that of the assailant, who has to suspend his fire while moving. A moral ascendancy on the part of the attack is required, capable of resisting such a superiority of conditions. The tactical object can only be reached at the price of certain sacrifices, to which we must make up our minds. A timorous preparation of the assault, with a small proportion of the force, can only serve to raise the tone of the defence."

It must not be forgotten that the extended firing line is now the attacking formation. Columns of attack are now inadmissible under modern fire, and they have been replaced by a dense line of skirmishers with large reserves in rear to draw on. Victory now, as ever, depends on the final close attack of masses, and the problem is how to get the mass across the fire-swept zone to deliver its assault. Formerly it was effected by a thin line of skirmishers engaging the enemy, followed by closed columns for effecting the assault, now it is effected by the skirmishing line itself, which has to be very dense, for the purpose of giving it sufficient moral and material strength for the purpose. But it may be asked how is such a line to live under the accuracy of modern fire, and arrive at assaulting distances? The answer is, it cannot do so unless the defenders

have been sufficiently shaken and demoralized by a preparatory artillery or combined artillery and infantry fire of some hours duration on the main points of attack. Experience has shewn that wherever this has not been done the attack has failed, by being brought to a standstill, or driven back by the fire of the defenders, provided that the ammunition of the latter has not run out, as that of the French right did at Gravelotte. This preparatory action is the true secret of the success, and even possibility of an assault, against troops armed with modern weapons, and skilled in their use. Both Germans and Russians suffered terribly when they neglected this principle of modern tactics.

"The German infantry, from its sound tactical judgment, has escaped from the *danger* which seems to threaten that arm of the service in other countries, viz: of having the formation *of its front line regulated solely with the view of avoiding loss.* In order to reduce losses, they choose formations suitable for overcoming the resistance of the enemy as quickly as possible, and not those which are least obnoxious to loss." "*You cannot make omelettes without breaking eggs," and no success can be gained in war without a sacrifice.*" "Thus the Germans give preference to such formations as best assure the exercise of command, the cohesion of the force, the connection as well as the reciprocal action of its different component parts, and above all to the vigour and even solemnity of its attack. It is, they say, the long-protracted, indecisive, wavering actions which lead to the greatest losses, and not those vigourously and rapidly carried out. All the German military writers, even those who demand the largest concessions to fire tactics, appear to be unanimous in maintaining and fostering the offensive spirit in their infantry, a spirit which seeks, *after the preparatory fire of the artillery*, to bring up to within effective range of the enemy, *opposite those parts of the hostile line which have suffered most from the cannonade, and where the fore-ground is most favourable to their approach*, troops well in the hands of their leaders, and with their pouches as full as possible."

Thus the rule is to gain a decisive effect with the greatest rapidity possible, and to do this, we must bring up the greatest number of men possible, in order not to reduce the useful effect of the fire by a too great rapidity of fire, which injures the accuracy. The number of cartridges to be fired are better expended by a large number of men firing a few rounds in a short time than by fewer men firing more rounds in a longer time. In the former case also the men's personal

supply of ammunition will not be so weakened for further action,—a very important point. In Continental warfare, one man per yard can be used in the attack or defence during the first phases of an action, after a suitable artillery prepartion; in savage warfare, double this number can be used.

If a decisive effect is not aimed at, then only enough rifles may be brought into the firing line to check the enemy seriously, should he try to advance.

The German regulations say that if two sights are employed, then there is no advantage in firing with less than eighty men (a third of a company), and if three sights, a whole company (250 men) should be employed.

The Austrian regulations say that "To ensure a reasonable effect with long range fire for a given expenditure of cartridges, it should not, as a rule, be undertaken with bodies of less than fifty men, and then only against deep columns and masses, such as company columns, closed supports and reserves, or thick shooting lines in the open up to 1,000 yards, or against battalion or squadron columns under like conditions up to 1,200 yards. If any of these objects are partially hidden, they should have a greater depth than indicated above to justify their being fired at. Batteries of artillery and large general staffs may be fired upon up to 1,200 yards under any circumstances."

"If it is proposed to employ infantry against artillery, the Germans say, a distinction must be made if the artillery is occupied elsewhere or not. When a battery is in action against artillery, a single company (of 200 men) may be opposed to it at from 900 to 1,300 yards. But if the battery is not occupied elsewhere, and can turn its fire on the opposing infantry, then the Germans would employ at least four companies (*i.e.* a battalion), against the battery, because the result of experiments made by both the French and Germans has shewn them that at these two ranges a battery produces an effect equivalent to twice and four times, respectively, that of a company of 200 men*. Similarly, when infantry seek to prevent artillery from taking up a position, it should employ at least a battalion, so as to spread death amongst

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* An English battery will probably require more infantry to silence it, from its superior shrapnel projectiles. Each shell of the new 13-pounder field gun carries 116 bullets. A battery of 9-pounders can even now defend their own front, if the ground is open for at least 1,000 yards to the front.

the teams and men, and throw it into disorder before it can unlimber."*—(*Revue Militairé de l'Etranger*).

3.—On the Choice of the Ground to be Taken Up by the Men.

The German regulations say that a free field of fire is the first condition; to shelter oneself from the enemy's fire is only a secondary consideration. Consequently, the men in the firing line must be pushed on to the further edge of any cover, or to the top of any rise in the ground, until they can plainly see the enemy they have to fire on.

4. The Selection of the Objects to be Fired on.

"The fire of infantry in war has for its object: *on the offensive*, to facilitate the advance of the assailant by destroying the force of the resistance of the enemy on each successive position that he may occupy, in such a way as to capture as rapidly as possible, and with the least loss, the 'key' of the battle field, while causing the enemy the greatest loss possible in order to ensure a prompt and demoralising retreat, and to prevent any offensive returns on his part; *on the defensive*, to retard and prevent the advance of the assailant, by inflicting the maximum of losses on him and throwing his ranks into the greatest disorder, then, when he has nearly reached the defender's position, to destroy him and force his retreat by overwhelming him with projectiles; in certain cases, the fire has only a purely demonstrative object, which consists of merely holding the enemy at certain points, while the real resistance or attack is made at others.

"Thus a battle is a double problem of fire and manœuvre. To reach the enemy and drive him off; to wait for the enemy and repulse him; these are the objects. The fire is only a means, though the preponderating one, either by its destructive or even moral effects."

Colonel Bavay, a Belgian officer, who has lately given some interesting notes on the choice of objectives in action, writes, "However important different methods of executing fire may be in influencing the efficacy of the fire, yet this

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* As to the tactical power of field artillery when well used, see a paper entitled "Infantry Fire *v.* Artillery Fire," by Col. L. Hale, R.E., in Vol. XXVII. (p. 247) of the *Journal of the Royal United Service Institution*.

efficacy can only produce any useful effect from a tactical point of view if it stops or paralyses the enemy's movements and breaks his combinations. Thus we must try more to obtain useful effects than merely the satisfaction of inflicting some losses on the enemy, for however great these latter may be, they are of little use if they do not prevent his final success. It is therefore very important from the first to seek the means of giving to the efficacy of the fire the greatest sum of useful effects, that is to say, its greatest tactical gain; and this should be the principal object studied by tacticians, as their speculation would be of little avail if they do not give the most capable means of rapidly ensuring victory.

"In order that the losses inflicted on the enemy may produce the greatest useful effect, it is necessary that they should be inflicted on those groups of the adversary's disposition for attack, which, by their *rôle*, strength, and situation, can exercise a serious influence on the course of the action, and these, as the opportunity occurs, should be immediately destroyed or weakened. It can be therefore said that it is on the best choice of the objectives to be fired on that the greatest tactical result of the efficacy of the fire depends.

"The question of the choice of the objectives is a capital one; it dominates all others in connection with the direction of fire."

A French writer says:—"On the offensive, as well as on the defensive, it is necessary to avoid scattering the fire. In accordance with this principle, the objects aimed at are to be changed but rarely, and if new objects of distinct importance appear, it is better to send fresh bodies into the firing line to fire at them, rather than to change the original direction of fire of the troops previously engaged." But this can only be done when gaps exist in the fighting line, or if the new troops can be brought up on the flanks.

The French regulations say:—"The fire of a sufficient number of rifles having been concentrated on clearly defined objects, all changes of objective should be carefully avoided, so long as the result first intended has not been obtained."

The German regulations say:—"It is necessary to remark, that too frequent changes of the objective lead to a scattering of fire, and therefore it is very necessary to avoid doing so.

"The objects are chosen primarily according to their importance from a tactical point of view, and then the fire can be directed on such objects which, by their dimensions, and

by the configuration of the ground, promise some chances of obtaining a serious effect.

"The judicious choice of the object, and the concentration of the fire on this object, are some of the most difficult duties in the direction of the fire."

Again, they say:—"Up to 800 yards, all objects can be successfully hit by the collective fire of groups, but beyond this limit, fire should only be opened exceptionally, and then only on objects whose dimensions offer favourable chances. These objectives are, for example, batteries and considerable masses of troops, which can, if necessary, be fired on with good results up to distances of 1,300 yards."

The Italian regulations say:—"In all cases the choice of objectives ought to be principally subordinated to the tactical needs of the moment. If from a tactical point of view, many objectives have the same importance, that one should be chosen which has either the greatest depth; or the greatest visible height, or is situated on ground most favorable for efficacy of fire."

The Belgian regulations say:—"In action, it is the duty of the leaders to direct the fire of their men to obtain advantageous results from it.

"A judicious conduct of fire is one of the most essential guarantees of success. . . . .

"In the deployment, it is necessary to tell off a section of the front to each unit. . . . .

"One ought to insist, with regard to the general direction of the fire, on concentrating the fire on the same important point, and during a very short time.

"A very frequent change of objectives conduces to the scattering of the fire.

"The objects will be chosen, in the first place, according to their importance from a tactical point of view; and, in the second place, the fire can be directed on those which offer some favourable chances to be hit, by their dimensions, the configuration of the ground, &c."

Thus we see that most instructions on the choice of objectives are rather vague. Colonel Bavay's *brochure* on the subject gives the most complete rules for guidance, and most of the following remarks are extracted from it.

So long as the enemy's disposition for fighting can be clearly made out, it will be relatively easy to make a judicious choice of the objectives to be fired at. This is usually the case in engagements of small units such as battalions, &c.,

but when many battalions are engaged side by side, each of them fight on a restricted front, and although the disposition may be clear enough at first, yet it soon presents a confused aspect, from the different groups in the first echelon or firing line not advancing at the same rate, and from the corresponding groups following in rear in the second and third echelons not being able to follow their movements with regularity. The parallelism of the echelons is therefore soon broken up. Again, the echelons in rear of the firing line seek for shelter, and in doing this drift to the right or left of their true line of advance. Thus, from the unequal progress and lateral displacement of the different groups, certain zones of the enemy's field of battle soon do not present any semblance of the original disposition, which alteration is still further augmented by any false direction taken by the men in the firing line.

Now, if we consider that this disposition, when viewed obliquely, would appear still more confused, we can lay down that the *first rule* in the judicious choice of the objectives to be fired on, is that, *provided the enemy in front is making a serious attack, which it is very necessary to destroy, and that he is within range, we ought to particularly select objects in the part of the enemy's fighting disposition directly in front of us, leaving to the neighbouring troops on the right or left the duty of dealing with the objectives in the parts of the disposition opposite to them.*

But, as a number of groups may appear in the part of the enemy's disposition in one's front, we must further choose between them. The firing line of the enemy, although weak at first will soon become menacing; but it has too feeble an effective to be able of itself to obtain a solution. Behind it comes the second echelon or the supports, who, when they join the firing line, carry it forward with fresh ardour to the zone of efficacious fire, from whence they prepare the final phase of the fight. Further in rear is the third echelon or the reserves, who reinforce the supports when it is necessary, follow their movements, and wait for the moment of the assault. Confident in their numerical force, and stimulated by the real progress they see, they soon join in their turn the most advanced groups, and giving them an energetic impulsion, they push on the mass of the combatants to the assault of the position.

As to which of these echelons should be fired on at the beginning of the action and during its different phases, will

be pointed out presently, but it may be stated, that however good may be the reason why, at a given moment, one objective may be selected in preference to another, it does not follow that according to the enemy's progress, the objective to be fired on should not have to be frequently changed ; on the contrary, the objective must be changed according to the variable conditions of the fight. But too frequent changes cause a loss of time, and lead to a scattering of losses, which prevent them from producing in any part a decisive effect. Hence, *unless a stronger reason does not require us to act otherwise, we ought to fire on the same objective until we have destroyed it, or at all events, until we have inflicted on it sufficient losses to temporarily paralyze its action.*

The *rôles* of the different echelons in a fighting formation, stated above, show that these echelons are the "organs of action" of the fighting disposition. The mechanism of their movements has been so regulated as to give the disposition the maximum tactical effect, and hence, by considering the *rôle* of each of them, and the influence they exercise on the course of the fight, we can determine in which of the echelons we should choose the objectives to fire at.

The duty of the firing line is to open out a way for the echelons in rear. It exercises a considerable influence on the progress of the fight, as a bold or timid advance communicates itself immediately to all the disposition—success or defeat can almost be foretold by it. The fact of the first echelon having to make use of its fire to partly annihilate that of the enemy, and create a veil behind which the whole of the disposition can advance, is an acknowledgment that the fire of the defender is much more efficacious than that of the assailant, and consequently to avoid a certain destruction, before he can act with the bayonet, he will do all he can to shorten as much as possible the phase of the fight in which he finds himself in inferior conditions to the defenders. *Hence, it is necessary, in principle, to choose the first objectives to be fired at, among the groups of the nearest echelons which threaten the greatest danger.*

General Skobeleff said in his instructions issued to the troops sent against the Akhal Tekkes :—"Even in European wars it is most important to observe the foremost groups of the enemy ; it is not really the mass of individuals present on the ground that decides the victory, but the progress which, thanks to different circumstances, a few brave men may make advancing in isolated groups. Consequently,

every attention must be paid to the appearance of groups of this nature, and direct on them by means of volleys the full power of your fire, for if you neglect to inflict great losses on them, these groups will increase in size in a wonderful way and decide the affair in their favour. . . . I counsel the leaders of all fractions to keep a watchful eye on these advanced groups; there is not a doubt but that, in annihilating them, we destroy (in the germ) all the initiative force of the rest of the mass." To effect this General Skobeleff recommended controlled firing in the animated words given on p. 415.

But during the course of an engagement the nearest troops of the enemy are not always those which it is necessary to destroy first. Thus when the attack begins with an artillery duel, the infantry covering the artillery do not constitute the most immediate peril to the defenders, as the artillery alone then fire with efficacy, and the defenders cannot hope for much effect with their fire against the first echelon of the enemy, on account of its distance, and of the groups composing it being scattered. But they can on the other hand, if they are in a good position and know the ranges, cause sensible losses on the artillery, which offers wide and deep objectives.

During this artillery duel mounted officers are sent to reconnoitre the position or to carry orders, and if possible they should be shot, so as to delay the elaboration of the plan of the attack, and to injure its execution by preventing the troops receiving their orders.

Thus the first exception to the last rule given is that *when the attack begins by an artillery duel, and the guns are within rifle range, or when during this prelude to the attack, mounted officers are seen making a reconnaissance of the position or carrying orders, we should select as objectives, the enemy's artillery and these mounted officers.*

When the fire of the defenders compels the enemy's firing line to halt, then the second echelon will come into action, and to do so it will have to approach the firing line. Up to this point the supports will have taken care to keep themselves sheltered from the defender's fire, but now they will have to show themselves to reach the firing line, presenting new objectives on which it is necessary to inflict losses, because if they are destroyed they prevent the firing line advancing. If the second echelon fails to produce the desired result of carrying forward the firing line, the third echelon will be similarly used, and should be fired on for the same reason.* Hence the second

* See footnote on p. 222.

exception to the last rule given is, *when the most advanced echelon of the enemy cannot any longer advance, then we must select objectives to fire at, first in the second and then in the third echelon, when they advance.*

Further, if the firing line is halted for any reason, and offers very bad objectives, then the fire may be directed on objectives in the second or third echelon, provided such exist with a depth, height, and width, suitable to the range.

The necessity for accumulating large forces in certain parts of the battle field in order to carry on the assault at these points, causes only a relatively small quantity of troops to be available for the other portions who can then only have a demonstrative *róle*. The firing line may not, in such a case, press forward very far, and its fire will be more noisy than efficacious. The *róle* of the second echelon will be to feed the firing line, so as to maintain its density, in order to prevent the enemy realising the merely temporising effort being made. In this case the enemy's firing line should be fired on, so as to prevent it subsequently attempting to alter its *róle* and take the offensive. The tactical object, the immobilisation of the firing line, being attained, either by the whole or part of the defender's forces, or if there is any certainty of its being attained, then more favourable objectives in rear should be fired on, if they present themselves.

Considering the important moral *róle* played by the troops in rear of a defensive firing line, and that the assailant has as a rule no immediate fear of any offensive action on the part of this firing line, they ought always to fire on the supports and reserves of the defenders whenever they appear in sight.

At the close ranges the men will fire only on the echelon nearest to them, as it will appear to them to be the greatest danger, and they will be too excited and uncontrolled to listen to orders to fire on any other objective.

The Turks in 1877-78, employed picked marksmen to fire on the officers of the enemy. This is a very good proceeding, because officers have a great influence on the progress of an attack; the men, having been trained to do so, look to them for orders and guidance, and when the officers are down, and orders are not forthcoming, the men begin to get out of hand, and the progress of the attack is delayed.

From all that has been said about the superiority of collective fire over independent fire, it cannot be too strongly laid down, that *when there are many groups in an objective at different ranges they should each be fired on successively with a collective fire*

from the greatest number of rifles possible, and every effort should be made to prevent the fire being rendered inefficacious from its being directed on all the groups at once, in order to produce the greatest tactical result possible during the duration of the fire; but if all the groups are at the same range then the men may fire at the group in front of them. The greater the range the greater are the number of men required to obtain an efficacious collective fire.

But these groups, in any one echelon, may not all have the same importance, and hence we must consider which to select. Including under the word "vulnerability" the effect on the fire of cover and of the formation of the enemy's troops, the different objectives may find themselves in one of four conditions:—

(a) Having the same effectives and vulnerability.

(b) Having the same effectives and different vulnerabilities.

(c) Having different effectives and the same vulnerability.

(d) Having different effectives and different vulnerabilities.

In the first case, in order to act so as to gain as quickly as possible the greatest tactical result, we ought to fire on those objectives which have others in rear of them to be hit by bullets going high, ricochets, &c., or on those groups at which officers and mounted officers can be seen, or on the most forward groups, the destruction of which demoralises those in rear.

In the second case the objective having the greatest vulnerability should be first selected to be fired on.

The third and fourth cases are not so easy to deal with, as they are also governed by the *rôle* to be played by the objectives in the action, and so it is not entirely a question of material losses. Thus in the third case, though two supports (of unequal strength and in the same formation, &c.) to different parts of a firing line cannot be absolutely prevented from reaching it and carrying it forward, yet in some cases it would be better to fire on the weaker one, to prevent that portion of the line being carried forward so far as it would otherwise have been.

With regard to the fourth case, in a fight there is no time available for minute decisions, and it is best to always select those objectives which have the greatest effective and vulnerability, to fire on first,—the question of vulnerability overruling that of effectives in any case of doubt. By this means, we not only are certain of inflicting losses most rapidly,

but also, as soon as we have obtained by the fire directed on the selected objective, the tactical result hoped for, we can direct the fire on another object in more advantageous conditions, as the vulnerability of this object (which was less than that of the first one selected), will have increased with the diminution of the range.

"The choice of objectives should be determined, first by their tactical importance, and then by their vulnerability. To avoid changes in the objective, to decide exactly on the object to be hit, and to direct the fire on it well, are some of the greatest difficulties in the direction and conduct of the fire."

Thus, we see, that to enable the responsible leaders in a firing line to make a good choice in their objectives, it requires on their part, a considerable knowledge of tactics, of the influence which the different arms, and even small units of them, play in the different phases of a fight, of the relative vulnerability of different formations at different ranges, and of the effect of cover.

From the intimate connection between the firing line and the echelons in rear of it, which are for its support, and to enable it to move forward by the impression they give to it, attacks have often been stopped by the supports and reserves having been driven back by fire, who were soon followed by the firing line. A notable example of this has been given in the footnote to p. 222. Hence it is a great advantage if one or more tiers of fire can be obtained from the formation of the ground, from which a fire can be directed at the same time on the different echelons of the attack.

When a line of skirmishers advance, or rush forward to gain a new position, a strong collective fire should be poured on them to try and drive them out of it before they are fairly established in it.

A plan which is sometimes used by artillery, might, in many cases be also used by infantry with effect: this is to choose certain marked lines across the enemy's advance; ascertain the exact ranges of them, and keep up a heavy fire over them when he reaches them.

As a general rule, the selection of objectives for infantry can be guided by the same rule as that used for artillery, viz.: *that they should fire on the leading echelon of that arm, which for the moment constitutes the chief danger to the defence, but only if this echelon is within effective range.*

To enable the selection of objectives and the concentration of fire to be effectively and promptly carried out without

indecision, the front of an enemy's firing line should be divided up into sections, and each one given to a battalion in one's own firing line. Each battalion will select its objectives in the section told off to it, until it has paralysed the action of the enemy in this section, when it may turn its attention to helping the troops on either flank. The brigade commander, knowing the extent of the enemy's front that he is operating against, would be the officer who would apportion it among the battalions in his firing line. The battalion commander could do the same with regard to the company units.

The Italian regulations say, "Efficacy of fire and fire discipline are more easily obtained, if each section (60 men) has assigned to it a particular zone to fire against, and if a certain interval is left between these sections, while maintaining a strict connection between them."

Hitherto, we have only dealt with frontal fire, but this fire has nothing like the material and moral efficacy of *flank or cross fire.* Hence, troops, unless seriously engaged in front, should always try and make use of this kind of fire, when possible. Those portions of a defending force which are only being opposed by a demonstrative action, may, after putting a definite stop to it, leave a portion to prevent the assailants re-taking the offensive, and, with the remainder, if they are even within long rifle range, pour in a fire on the flanks of the assailants, who are making an energetic attack on the neighbouring portions of the position. Even the sound of bullets coming from a flank will intimidate men, and make them hesitate to advance, or even retire if they are not well disciplined and completely in hand.

Modern battles on an extended scale are only a series of small battles or fights in which bodies of troops, perhaps not greater than a brigade, are engaged. The small fights rage round the different strong points in the position, which act as bastions along the front, and from which a powerful flanking or cross fire can be poured on troops trying to penetrate between them. The assailants, in striving to capture them, try to work round their flanks, and so to surround them on all sides, but in doing so they must expose their flanks to the defending troops in the intervals between the strong points. Thus a skilful defender will find many opportunities of using a flank and cross fire with great effect, and the objective for the fire should be one, which, if destroyed, would have most effect in rolling back or even stopping the advance, due consideration being had to the relative vulnerability and effectives

of the objectives formed by the enemy's troops and echelons of attack.

5. Determination of Range* and Choice of Sights.

At short distances the correction of the fire is easy, for great errors cannot be made in the choice of the sight; these errors besides will be partly compensated for by the great flatness of the trajectories. With the Martini-Henry rifle in using the elevation for 400 yards† with a fine foresight, which is the true elevation for the close fight, and aiming at the feet of the enemy, the ground is beaten up to 400 yards, by direct hits and the ground beyond is rendered dangerous by ricochets if it is favorable. The sight for 400 yards is also the best elevation for cavalry at short distances.

At greater distances the correction of the fire necessitates as exact an approximation as possible of the distance of the object, as well as a knowledge of the influence of atmospheric circumstances, especially of the temperature and of the wind, on the direction and range of the bullets.

The efficacy of the fire of masses of men, even if not collective, depends, like that of individuals, more on the exact range being known, than on the individual skill or training of the men, for the one is a fixed unalterable quantity, while the other is a variable moral factor, never very reliable in action at the best of times, and which is influenced by whether the men are fatigued or not, by their state of mind from the excitement produced by the effect of the enemy's fire, by the fear of death, and by the surrounding sights and noises. So many things tend to make the firing, even of masses, unsteady in the field, that we feel justified in saying that, *in action the efficacy of the fire, of troops (disciplined or not) depends more on the range being known than on the individual skill or training of the men in shooting.* Unless the range is known the very best fire may not hit the mark, while if the range is known the very worst may do so. Thus nearly everything depends in firing, on the range being known, and hence every officer, and even non-commissioned officers, ought to have a simple portable range-finder, by which ranges can be determined rapidly, even while lying down, up to 1,200 yards, within a less percentage than $\frac{1}{8}$th of the range, so as to be better than judging by the

* This question has been more fully gone into in chapter VIII.

† Or the 300 yards elevation with a full foresight.

eye. To within $\frac{1}{12}$th of the truth might easily be got, which would only require the use of one sight up to 600 yards, and two sights up to 1,200 yards, according to the calculations already given in Chapter IX.* The eye is the very worst means of judging distance, for no two men will give anything like the same answer with confidence; practically it is entirely guess-work, and the greater the inaccuracy of the method of estimation, the more it is to be deprecated, as it causes greater waste of precious ammunition. Therefore the use of a simple, easily and quickly worked portable range-finder, which can be worked lying down under fire, having as a base the length of a rifle or sword for ranges under 800 yards, and a longer one for ranges over this, may be considered absolutely essential, even if it can only read to $\frac{1}{12}$th of the range up to 1,200 yards.

From the importance of knowing the ranges, the distances of various prominent objects should be measured, when time allows from certain points and noted, and even certain ranges marked out when on the defensive; information as to ranges should be asked for from the nearest troops, especially from the artillery as they are passed, the ranges under this being deduced; maps should be consulted, range-finders made use of, or the distances determined by any other method, as by eye, the mean of the observations made by several persons being taken; or, if the ground is suitable (*i.e.*, open, dry, and sandy), trial volleys may be employed, taking care to use rather a low elevation at first.

When a valuation of the range has been decided on, the choice of the sights to be used is made in accordance with the principle laid down in Chapter IX, remembering that the condition and training of the troops, the mobility of the objective, atmospheric conditions,† and the slopes of the ground near the enemy, &c., all affect the number and choice of the sights to be used, as well as the probable error of estimating the range. It should be further remembered that all peace experiments show that better results are obtained, even at long ranges, when the fire is rather short, especially when a

* This is all the more necessary in the English service, as the sub-division of the English company does not lend itself easily to the use of three sights over 800 yards.

† That is, pressure of air, due to altitude of locality, temperature, and wind. The effects of a head or rear wind are often as great as the probable error in estimating the range.

combined use of 2 or 3 elevations is made, than when the sights are adjusted exactly to the supposed range.

As a rule it is most convenient in collective firing to order such elevations as are multiples of 50 or 100 yards, as they are quickest and most accurately taken up. The constant beaten zone of 100 yards minimises any errors caused by so doing. But sometimes intermediate elevations may be used, especially against small and stationary objectives at known ranges, and when the observation of the results of the fire can be easily made.

For the close fight, also, General Brialmont recommends using a lower elevation than that for the true range, with aiming at the feet to correct the effect of the error of firing too high, and to benefit by the ricochets. "In order to avoid the effects of too high a fire and the difficulty of getting the soldier to alter his sights within the zone of very efficacious fire (500 mètres), a rather lower elevation than that for the range should be used in the attack. For example, use the 400 mètres elevation at 500 mètres, the 300 mètres elevation at 400 mètres, and the 200 mètres elevation at 300 mètres, which will be retained until the end of the fight."

Also it must be remembered that men firing downhill are apt to fire higher when excited by the proximity of the enemy than when firing uphill, and so a lower sight should be used in the former case than in the latter for the same range.

Against cavalry, almost all Continental nations lay down that short range fire only is to be used. The German regulations state that the 350 mètres sight is to be used against cavalry, and the French regulations lay down the 400 mètres elevation. The Russian regulations are more decided, for they forbid a fire against cavalry at longer ranges than 400 paces (333 yards). The reasons given for this are as follows:—

1. The uncertainty of hitting at longer ranges an object moving forward with so much velocity.

2. At longer ranges the sight would have to be constantly adjusted, which causes a loss of time.

3. The essential point is not so much to cause heavy losses among the mass of mounted men, but much more to break the spirit or dash *(élan)* of the charge, by bringing down a number of horses.

4. A body of cavalry, exposed from the beginning of its charge to a fire of poor efficacy is not influenced by any moral deterrent; but the opposite is the case when this body is kept under the constant menace of a sudden and terribly effective discharge.

The above rules, given in the Russian regulations, and the reasons for it, appear so logical and irrefutable, that we should do well to accept it in our tactical procedure.

The Belgians recommend fixing the bayonet just before meeting a cavalry charge, if there is time to do so, as a moral support to the men, and then to only open fire at 400 mètres with the 300 mètres elevation. A volley can be given in each 150 mètres crossed by the cavalry, so that the third volley would be given at the 100 mètres range if the cavalry had pushed on. If the fire is opened too soon, at 450 mètres, this error has been found, by experiments, to have but little influence on the results, on account of the great extent of the dangerous zones and ricochets at close ranges.

It is almost needless to say that the same point should always be aimed at on charging cavalry, to prevent loss of time in giving orders which may not be obeyed. At such short ranges the men would fire straight to their front.

6. The kind of Fire to be Used.

Now as we have seen a commander can choose between two kinds of fire—

(i.) Independent or uncontrolled fire; and
(ii.) Collective or controlled fire.

But as fire discipline and direction entirely depend on control, *independent fire*, from what has already been said about it in Chapter XIV., is only to be tolerated when these are not possible. The effect of such a fire is usually very weak, except at the very shortest ranges (*i.e.*, under 400 yards), as it is made up by the independent fire of individual men, which is only effective up to such ranges, and if these men are excited, or out of hand from the effects of the enemy's fire, it becomes wild, and cannot be stopped until the last round is expended. It should only be tolerated at the shortest ranges, where a single man may hope to hit the object he aims at while firing at his own discretion and freely choosing his own objective.

The controlled fire of men may be executed in two ways:—

(*a*) By the *individual fire of the mass* or *mass firing*,* as it will

* This fire is generally called "individual fire" or "fire of skirmishers" in the regulations of foreign armies, but these names are not used here, to prevent any confusion which might arise from a different meaning having already been attached to them in previous pages.

be called, in which each man fires the number of rounds stated, at his own convenience, at the named object, and with the sight or sights ordered, thereby causing, at *intervals*, a *continuous* rain of projectiles to be concentrated on the object.

(*b*) By *volley firing*, in which all the men fire together simultaneously by word of command at the named object, and with the sight or sights ordered, thereby causing a concentrated mass of projectiles to be suddenly projected *at the same instant*, but at *intervals*, on the object fired at.

Both mass and volley firing can be carried out by closed or extended bodies of troops, but volleys require considerable control over the men, and can, therefore, only be executed in action by extended men at the medium and long distances, when the required control is possible.

As close order formations cannot exist under modern rifle fire, volleys and mass fire by troops in close order can only be used under special circumstances, as, for example, in savage warfare, when firing after retreating troops, when troops out of infantry fire are threatened by cavalry, &c. Thus they are not of general practical use in the ordinary conditions of Continental warfare. English companies of 100 men are perhaps the largest unit they are applicable to under any circumstances, from the difficulty of one man controlling a larger body.

The essence of a collective fire is control, so as to get the greatest effect possible out of it. *In order to control infantry fire and to allow it to be effective, there must be pauses in it*, during which the smoke is allowed to clear away, the effect of the fire watched, and orders and information transmitted as to the object to be fired at, the ranges, and the sights to be used, &c., &c.

The Germans and French lay great stress on these pauses for another reason. They deprecate a slow continuous fire for infantry, because it causes too great an expenditure of ammunition, and gives none of the advantage gained by the moral effect caused by sudden losses. They say that the action of fire should be sudden, unexpected, and powerful, so as to have an offensive aspect, and that this action should be felt only during successive very short periods, divided by pauses which are utilised as above stated. The French regulations say that, "The suddenness of fire is one of the principal conditions of its efficacy. The moral influence of a material result is greater as this result is obtained in a shorter time."

This sudden and powerful action can only be obtained with troops perfectly trained in fire discipline, and when the direction and control of the fire have been thoroughly practised. This kind of fire is considered to be more impressive, to require less ammunition in obtaining a certain result, and to gain this result in less time than a sustained slow and continuous fire. The Germans always endeavour to get a maximum effect in a minimum of time. "One ought to try, as regards the general direction of the fire, to concentrate the fire on the same important point, and during a very short time." It may be remarked that the Austrians advocate a sustained slow fire.

The French say, further, that a slow fire, executed by isolated men, has no useful effect; it presents, moreover, the inconvenience of retarding the advance.

Although the German regulations lay great stress on the suddenness of fire, and lay down that men advancing under fire are to do so by successive advances of fractions, during each of which all fire is to cease, and after which the sudden fire is to open, yet in some parts of the German army their practice differs from this, for the men have been taught to deliver while advancing over the longer ranges, a mass fire of a stated number of rounds, by each man in succession of a group or other named unit running out to the front, halting, kneeling down and firing, and then waiting for the line to come up to advance again with it and to await his turn. They trust to the discipline and training of their men to effect this without confusion.* It is considered that such a method is more adapted to keeping up the moral force of the men, who will advance more readily when firing, as it helps to keep up their spirits, and tends to demoralise the enemy. These remarks do not apply to the method of advance by short rapid rushes at the close ranges, because these rushes are made at full speed, to avoid loss, and therefore no firing can take place during them.

In volley firing a pause is obtained at the end of each volley, but in mass firing the only way to obtain the pauses, and to prevent the fire escaping from control and degenerating into an independent fire, is to limit the number of rounds to be fired by each man, who must then cease firing. *The number stated should not exceed four*, as men under fire,

* It would seem preferable to make the men fire thus in groups (see pp. 106 and 128). Each group should run out to the front under its leader and halt for the line to come up. Control over the men would be better kept up by such means.

especially if excited, cannot be expected to keep count of a greater number.

The success of this plan for controlling a mass fire is doubted by Von Boguslawski, who considers that in the excitement of battle, the men will not attend to the order for limiting the number of rounds, and that *a whistle*, specially constructed for shrillness, is the only thing that will stop the fire at such moments, if the men have been trained to it in peace. The Germans are great advocates for a very shrill whistle. They train their men to cease firing directly they hear the whistle, and to turn their heads towards their leaders to look for instructions. They say that it is too much to expect from men, under an efficacious fire, to cease firing after expending a certain number of rounds, without any further order, although they may do so at some distance from the enemy. The only thing that will then attract the attention of the men, is a shrill whistle, which should be used by all leaders of groups and larger units. The German Musketry Regulations of 1884 say, "It is necessary that men should be so disciplined that they instantly cease firing at the sound of a whistle; if it is necessary, the men firing should also pass down the whole line the order, '*Cease Firing*'." A whistle has been adopted in the English service, but it is rarely seen or heard on the practice ground. This is a great pity* as the idea is most excellent, and every means should be given to the leaders to strengthen their power of putting a limit to the consumption of ammunition, and of maintaining the fire in the appointed direction, even in the most trying moments. It is most important that the action of the leaders should be able to make itself felt at any moment, and even in independent firing, it must not, if possible, cease to exist. But this result can only be arrived at by most painstaking training, and by repeated exercises in times of peace. Uncontrolled independent firing should never be practised in peace time, it will come of its own accord in battle, but in peace drills and exercises the number of rounds to be fired should always be stated, to get the men into disciplined habits, even in the sternest moments.

The Austrians do not agree with the French and Germans as to the effects to be produced by the sudden opening of a musketry fire, broken by pauses. The Austrian regulations lay down that in a combined force of infantry and artillery, the

* Since this was written, it has been officially ordered that all officers are to wear whistles in uniform on parades for drill.

action of the former must always be prepared by the fire of the latter. "To the artillery must be given the means and the time necessary to effectively prepare the infantry attacks, by the fire of massed batteries." As soon as this preparation is completed, the infantry is to advance without stopping, if possible, up to the extreme limit of the medium zone, or better still, of the short ranges. Then, a fire, superior in energy to that of the adversary, is to be opened; and this fire is to be regulated so that it may always increase in intensity until it attains its maximum effect at assaulting distance. Neither concentration of fire, nor pauses, even by limiting the number of rounds, is aimed at, but every endeavour is made to limit the rapidity of the fire (*i.e.*, the number of rounds fired in a given time), and to gradually let it increase both in quantity (by the addition of reinforcements), and in rapidity, so as to give the fire an ever-increasing power, from the firing of picked marksmen, at first, up to the rapid fusilade of the firing line reinforced up to its maximum density. This gradual development of fire, they consider, can only be obtained with troops perfectly trained to fire discipline, and when the direction and control of the firing is under the control of the leaders.

It is very remarkable to see different large armies, who have each studied this question of fire tactics with the same earnestness for several years, come to such different conclusions on a question of so much importance.

Another great point of divergence, is, that the Austrians lay down that the independent fire of picked marksmen is the usual fire to be employed in the medium zone. The French and Germans are very decided on the uselessness of such a fire beyond 440 yards, and consider it to be a veritable waste of ammunition, because at these distances the skill of marksmen, and the dangerous zones of the rifle, are not sufficient to counterbalance the errors of judging the distance of an ever-altering range. If a marksman could fire a sufficiently large number of rounds, at the same range, and at the same *stationary* object, that is, under the same conditions,* the Austrian practice might have some reason, but as the men themselves, or the enemy, are moving, and so altering the range, and as they will, when left to themselves, fire first on one object and then on another, that is, the conditions under

* On p. 84 it was pointed out that the practical dangerous zones dealt with in Part I., depended on a large number of rounds being fired under the same conditions, *i.e.*, at the same point and range.

which they fire are constantly varying, the German and French practice must be considered the most practical and sound. On the battle field, the Germans, instead of letting ten men, choosing their own objects, fire 80 cartridges in four minutes on ten different objectives, prefer to concentrate, during half-a-minute, the fire of 80 men on the same objective, and then have a pause, and open fire again, on the next one, and so on.

In sieges, however, where the ranges can be accurately found, the supply of ammunition is unlimited, and the positions of the men and their objectives stationary, the fire of picked marksmen may then be very effective at any of the medium ranges.

But it must be remarked that the Austrians seem to be now coming round more to the German line of thought. In the *Revue Militaire de l'Etranger* for the 15th December, 1887, we read, that in the drill regulations of the Austrian infantry, "the different kinds of fire to be used are carefully laid down; "the volley of groups (*escouades*) being the most usual one. "The employment of rapid fire is limited to the decisive "moment of the combat. Individual firing is reserved for "the best shots only, and even in this case, the number "of rounds to be fired by them should be stated beforehand. "Long range fire (*i.e.*, at ranges over 1,000 paces) is only to "be executed by volleys of troops in close order, and only in "a small number of well-defined cases, and care is to be "taken that the ammunition thus expended is at once "replaced. Certain cases are foreseen in which the fire may "be suspended, especially when it is considered necessary to "do so to re-establish the fire discipline."

Advantages of Mass Firing as compared with Volley Firing.

1. Each man can fire at his own convenience better.
2. It can be used at shorter ranges.
3. It can be used at any range, by troops in any formation, and by any number of men.
4. It is more suited to moments of great moral strain.
5. A greater number of rounds can be fired in a given time, from the fewer pauses.
6. It is better suited to an extended firing line.

Disadvantages of Mass Firing as compared with Volley Firing.

1. Unless carefully looked after, and controlled, it may degenerate into uncontrolled fire, as it will do, in any case, at the short ranges.

2. Its moral effect on the enemy is not so great.

3. The regulation and alteration of sights is not quite so easily carried out.

4. The control over the men is not so great.

5. Its effects cannot be so easily observed.

6. The strike of the bullets can hardly ever be seen, to correct the sights by.

Advantages of Volley Firing as compared with Mass Firing.

1. It has a greater moral effect on the enemy.

2. It enables greater control to be maintained over the men, from the greater number of pauses.

3. It is not so likely to degenerate into uncontrolled fire.

4. The regulation and alteration of sights is more easily effected.

5. Its effects can be more easily observed.

6. The strike of the bullets can be better seen, to correct the sighting.

7. It gives a more certain method of directing the whole fire.

8. It is the best kind of fire for repelling night attacks, and for use against cavalry.

Disadvantages of Volley Firing, as compared with Mass Firing.

1. It is not so well suited to extended formations; it can then be only used by comparatively small bodies of men.

2. It is not so well adapted to all the circumstances of war.

3. It is not so suited to moments of great moral strain.

4. The men cannot fire so well at their own convenience.

5. It is not so suited to very small or very large bodies of men.

6. It is not so suited to short ranges, as it requires great control over the men.

7. From the greater number of pauses, less ammunition can be fired in a given time.

A well-adjusted mass fire is considered by the French and Germans to be slightly more accurate for a given number of rounds, independently of time, than volleys, but the difference, at the best, and on measured ranges, is only slight, and under the less favorable circumstances in the field they may, for all practical purposes, be considered of equal accuracy. But, in a given time, mass firing gives an undoubtedly better result or useful effect (see p. 101). This was proved in the Belgian

experiments of 1883, in which it was found that though volleys, at a range of 300 mètres gave the best *percentages* of hits, yet a rapid individual fire gives the greatest number of hits or destructive effect, from the greater number of bullets fired.

In Chapter VII., we saw that a more rapid and less accurate fire, could, within certain limits, give a greater useful effect than a slower and more accurate fire, though only of course at the expense of wasting a considerable amount of ammunition.

If aim is really taken by the men, mass firing gives rather better results, but, on the other hand, volley firing is the only real means of ensuring that the men do take aim.

The Italian regulations say that with mass firing "it is difficult to regulate the fire, and to maintain fire discipline. Mass firing, without *an iron discipline*, easily degenerates into a quick and unregulated fire."

Volleys are the only certain means of directing the whole fire on the object chosen by the leader, and we must remember that the one essential condition for efficacy of fire, over 400 yards, is to concentrate it on particular objectives, and not allow it to be scattered anywhere on a wide front. In volley firing the point to be fired at is indicated, the men only load and fire by word of command, the consumption of ammunition is strictly regulated, and all waste is reduced to a minimum. But volley firing requires great coolness on the part of the leader, as well as on the troops, and therefore it can only be employed at a certain distance from the enemy, unless the troops are covered from his view and fire. The German musketry regulations of 1884 state that volleys can be used in the opening phases of a fight, but they add that the troops which make use of them ought not to be exposed to an efficacious fire; but this same remark can be equally applied to controlled mass firing. The leaders must be very careful that the volleys are fired together, for if some men are allowed to fire before or after the others, independent firing will probably ensue. Unless troops are thoroughly well trained and disciplined, a controlled fire of any kind cannot be maintained in action, but will soon degenerate into independent fire.

In repelling night attacks, when troops are so liable to get out of hand, from not being able to see what is going on, volleys are the only kind of fire that it is advisable to employ to prevent a rapid, wild, independent fire taking place.

Another advantage of volleys over mass and independent fire is for use against a body of troops in motion, especially cavalry. Then volleys have a great superiority, in ensuring that an alteration of sights is made. Cavalry charge at the rate of 400 yards a minute, during which time two rounds can be fired with accuracy. Thus, if alternate units fire, one may use an elevation 200 yards less than the other.* Men would not thus regulate their sights in any other kind of fire. When cavalry are within 500 yards, the men cannot be relied on any longer to fire volleys, and will fire independently, which does not so much matter at this close range, provided they will cease firing when necessary.

But volley firing really requires the men to be grouped together near one another, either in single or double rank. But close order, in single rank even, is not permissible under 600 yards, against modern rifles, until the enemy has been demoralised, and the efficacy of his fire reduced, and therefore this may be taken as the minimum range in the open for volleys by any considerable number of men, though extended groups of skirmishers, when their tactical bonds have not been altogether dissolved, can still use them at a closer range.

The value of volleys is so great in supervision of fire and economy of ammunition, that they should be used as long as possible, by trying to make the skirmishers execute them in small groups, provided they can by so doing fire the number of cartridges deemed necessary in the desired time. If not, mass firing must be resorted to, in which a greater number of rounds can be fired in any given time, and thus a better useful effect gained. Though volleys and mass firing give much the same results in the field, for a given number of rounds, independently of the time they are fired in, yet the command and moral force that can be maintained is greater in the former case than in the other.

All the advantages of volley firing, however, must not be expected in war; still they should be aimed at as far as possible; and it is none the less certain that the more troops have been trained in time of peace to pay attention to the slightest sign or gesture of their leaders, the greater will be the discipline and power of control over them in the fight. It is a matter of peace-training and constant practice. *Troops which have not been broken into it, will not possess fire discipline, however much they may have been disciplined in other respects.*

* If cavalry are trotting, allow only 100 yards difference in elevation.

From the accuracy and power of artillery, troops have to break up in action into small groups at longer ranges than infantry fire would ever be opened at. Hence, if it is decided to open fire at ranges over 800 yards, it is undoubtedly best to employ volleys from small bodies of men, as also from the economy of expenditure, the power of regulating and watching the fire, the moral force imparted by a feeling of order, and the command over the men that they give. Hence the line of men required to give the requisite amount of collective fire must be divided into "*fire-units*" (see p. 406), and the commander of each fire-unit gets the order for the direction of the fire, which he communicates to the men, and sees carried out. As the enemy is approached, and his fire gets more accurate, losses occur, and the control gets more difficult; but, if any abnormal mixing of units has not yet taken place, then, by a judicious reinforcing, by pushing complete units into gaps, instead of directly to the front, volleys can and should be still continued as long as possible, by means of the small "fire-units," especially if the men are inclined to get out of hand. But if an irregular intermixture of units has taken place, or when the control for volleys gets too difficult, mass firing must be resorted to, and every effort made to maintain it until it develops of its own accord into a rapid independent or uncontrolled fire, in which the men will no longer pay attention to the directions of their leaders limiting the number of rounds to be fired, thus causing the pauses to disappear; after which, the personal example or influence of the leaders is the only controlling effect on the men, and then a few minutes will decide the action one way or the other. If the enemy is demoralised, from having suffered, materially and morally, from a sufficiently accurate and prolonged artillery preparation, and from the intense rifle fire that has been poured in on him, his fire will slacken, and the attack will rush forward to victory; if not, the attack will be driven back, which retreat, if unsupported, and if followed up by the defence, will be most disastrous to the assailants. Mass firing can be taken up by the same fire-units, when volleys are no longer possible. Before joining the firing line, all leaders must be informed as to the direction of the attack and the fire, and men who get separated from their groups ought, from previous instruction, practice and discipline, to join themselves to the nearest leader for the purpose of collective firing. Independent fire will dictate its own time and range; the greater the discipline, the longer will this undesired period be delayed.

The properties of volley firing are so seductive, in spite of their being harder to execute than mass and independent firing, that they have led to their frequent use in peace exercises at shorter ranges than practicable in war. Volleys cannot be enforced within the range of effective individual firing (*i.e.*, 400 yards at the least), because at that range they are, as a rule, quite impracticable in the field when opposed to civilized troops, for the noise and excitement of battle disconcert the troops, orders are no longer distinctly heard, or even punctually obeyed, every man seeks to obtain from the ground a shelter from the enemy's fire, the group units get involuntarily broken up, and independent firing will, if care is not taken, supplant that of volleys, without any human power being able to prevent it. It belongs to the leaders to foresee this moment; recognizing it in time, they will themselves order mass firing to commence before independent firing commences of itself; they will then, perhaps, with the aid of discipline, training, and shrill whistles, be able to preserve the direction of fire, and limit the number of cartridges to be expended, by naming at each pause the number of rounds to be fired, and making the pauses sufficiently long to allow the smoke to disappear and rectify the sights. Even though these results may not be fully obtained in war, yet they should always be aimed at.

Volleys can only be used at close ranges, even on the defensive, by troops who are well in hand, and who have been well trained, and possess a high degree of fire discipline. Thus, they are not so likely to succeed with young troops, or even with old soldiers, who are fatigued or excited.

Mass firing and independent firing are, therefore, as a general rule, the only kinds of firing possible at the shorter ranges, when all efforts must be directed to prevent them deviating from the original direction, and degenerating into a wild, irregular fire, so wasteful of ammunition, at a time when ammunition cannot be replaced.

Some writers assert that war experience has always demonstrated the impracticability of using volleys in action. Von Boguslawski is particularly strong on this point. In this authority's *Tactical Deductions from the War of* 1870-71, we find :—"The cases in which volleys were fired in a downright infantry engagement could probably be easily counted; the few cases, in which the use of volleys can be well authenticated, were when the French were surprised. Neither

French nor Germans ever succeeded in pushing forward battalions or companies to fire volleys. Even when on the defensive, to which, according to theory, volley firing is particularly applicable, it could so seldom be employed, that the few exceptions prove the rule. Even behind cover, field-works, barricades, &c., the fire of *dense clouds of skirmishers* was preferred to bringing forward bodies in close order to fire volleys."

But it must be remembered that in the Franco-German war, such a stringent fire discipline, as is now thought necessary to be instilled into Continental troops, did not then exist, nor any of the definite fire tactics now employed abroad. The contending armies had great numbers of young troops and reserve men; volleys were attempted by large units, such as by companies of 200 men strong, and they were tried to be used at very short ranges; so that in this war, everything was against the practicability of using volleys in action.

Everyone admits that volley firing in action can only be carried out, so long as fire discipline and control exist. Lieutenant A. Keucher, a well-known Belgian officer, writes:— "No one has yet been able to give an exact solution to the problem: *What are the best measures to take in peace time in order to keep the men in hand, in action?* Everyone is agreed that only those can maintain fire discipline up to a certain point who can keep their troops in hand. Many *indirect* means have been proposed to attain this object, such as volley firing, the individual firing of a stated number of rounds, &c.

"The next war will fix the value of these expedients; but no *direct* means have as yet been found, and it is not probable that any will be found, because *fire discipline depends exclusively on the general discipline of the troops*, and hence all peace instruction ought to impress on the soldier this conviction, that he ought always, at every moment of his military life, to subordinate his own desires and will to the higher ones of his chief, to give to this latter an absolute confidence, and to obey all his commands and signals. Those who, during peace time, will have instructed their troops according to these principles, will equally succeed in war to keep them in hand, *up to a certain point*. 'Up to a certain point' is expressly stated, because German officers recognise that, in action, the excitement of the men becomes so great at close ranges, that sufficient hold cannot be ensured over them to rely on their executing any orders with coolness." But the greater the discipline of the men, the nearer will this

certain limit of control, and therefore of volley firing, be to the enemy, if it is executed by small bodies, and not by large tactical units, as a whole.

The great superiority of volleys is the power they afford of being able to direct the fire of a number of rifles simultaneously on a named object, of obtaining from the men the necessary submission to discipline in order to drive the enemy's skirmishers out of any shelter they may momentarily have obtained, and of subordinating their desire to obtain cover to that of obtaining a good position for firing, as it is a well-known fact that men are, in practice, more pre-occupied with seeking to obtain shelter than with obtaining a good field of fire, and that careful aiming and steadiness can only be maintained in the heat of action by a rigid fire discipline. In other words, it is owing to volleys that fire can be maintained in the desired direction, which cannot always be done in mass firing. The expenditure of ammunition is not so great as in mass firing, from the greater number of pauses, and another advantage claimed for volleys is that they will keep the troops opposite to the objective assigned to them, and prevent that tendency to incline to the flanks, which is so noticeable in all recent battles, in the endeavour to seek a zone of safety. But on the other hand volleys are only possible, so long as the troops are beyond really effective range, from the difficulty of controlling the men sufficiently within that distance.

The value of volleys, as compared with mass firing, is undoubtedly more one of moral than material effect, both to one's own men and to the enemy, and as Napoleon I. said that moral effects are three times the value of material ones, volleys for this reason are to be preferred to any other kind of firing, when practicable.

The opponents of volley firing, as a rule, lose sight of this moral side of the question; they nearly always base their arguments on the relative number of hits made on targets by each kind of firing.

Volleys are, undoubtedly, most suited to the defensive, and for use at long halts, which naturally are of a defensive nature.

On the offensive, the use of volleys is principally confined to the period of preparation, and therefore belongs to long range fire, as a rule.

The French regulations say:—"Fire should be sufficiently slow to be well aimed. It ought to be often stopped by more or less long pauses, to allow the smoke to clear off, to judge the effect produced, to give the necessary orders, and to establish calmness in the men.

"The necessary pauses are naturally obtained in volley firing during the intervals of fire.

"In mass-firing (*les feux des tirailleurs*) the number of cartridges to be fired by each man, *three or four at the most*, is to be fixed before-hand, after which the fire ceases without further command.

"In order that the fire may be directed, and regulated, and that it may produce its maximum effect, it is indispensable that it can be instantly stopped, and begun again at the will of the leader.

"On the *defensive* the pauses in the fire will take place when the attacking troops are lying down or are sheltered.

"Often the suspension of fire, on a part of the line, will be useful to draw the enemy on to a point which he is thus induced to believe is abandoned.

"The sudden re-opening of the fire at a short distance will then produce on the assailant a considerable effect.

"The employment of volleys contributes to the maintenance of the control of the commanders over their men, facilitates the concentration of fire, permits of the rectification of the fire, by observing the strike of the bullets, and gives the means of regulating the consumption of ammunition.

"Volleys by squads or groups ought to be executed as long as the men can be kept in the hands of their leader.

"On the *offensive*, volleys belong to the long range period of the action. They are not to be used by the troops actually carrying out the attack, because they convey an idea of immobility and relative security, which are incompatible ideas with that of a vigorous offensive.

"Volleys will be executed by troops told off specially for the duty, by the reserves placed in positions on the flanks, or on any commanding places, or by troops only required to make a demonstration.

"Volleys are not to be expected at short ranges, not even from any troops in closed ranks, who may be brought up to reinforce the firing lines, unless they are sufficiently sheltered; after capturing a position, volleys constitute the best means of carrying out the pursuit and of regaining the troops in hand.

"On the *defensive*, the sheltered troops will make use of volleys as long as possible. Even at the last moment, when the assailants dash forward to the assault, volleys will be very efficacious against an enemy who does not fire, and who advances over the open.

"Volleys in closed ranks will not be executed in general by fractions of troops greater than a section (50 men). In certain cases they may be employed with half a company (100 men).

"Beyond 800 yards it will sometimes be advantageous to concentrate the fire of many fractions on the same objective.

"*Mass firing* well directed and slowly executed, gives results slightly superior to those of volleys, but it has the inconvenience of rendering the fire discipline, and the correction and concentration of the fire more difficult.

"*Rapid firing*, executed at a distance of 220 or 330 yards only, owes its efficacy to the flatness of the trajectories. Troops are forcibly led to use it when the moment of the final crisis arrives. Its duration will always be very short, and the crisis will immediately be followed by the solution."

The German regulations say:—"With volleys, by closed ranks or skirmishers, the troops are more readily kept in hand, and the commanders are more masters of the fire; besides it is easier to observe the strike of the bullets, and therefore to determine the sight to be used.

"Sometimes, with thick lines of skirmishers, the smoke which covers the front and prevents aiming, may sensibly diminish the chances of efficacy. In this case, the volley is to be preferred to mass-firing (*feu de tirailleurs*).

"In order to prevent mass firing degenerating into an irregular fusilade, it is necessary to fix, before the opening of the fire, the number of cartridges to be expended by each man; as a rule, not more than three. In this way certain necessary pauses are produced, during which the smoke clears off, and orders are disseminated. A rapid independent fire requires a greater quantity of ammunition than mass firing, it disquiets the men, and as after a few rounds the front is covered with a thick smoke, it soon becomes impossible to aim. Also, as it is much more difficult to direct this fire, and to discipline it, its employment ought to be limited to exceptional cases."

When volley firing is employed, it should not be executed by more than 100 men (an English company), or at a greater rate than 5 rounds a minute, in order to obtain the greatest efficacy from it; but the number of successive volleys should not exceed 4, without a longer pause to prevent it degenerating into an independent fire. Between each volley there should be sufficient time given for the men to load, aim and fire without hurrying them, and between every 4 volleys there

should be a sufficiently long pause to maintain calmness among the men, and to allow the smoke to disperse.

For some further remarks on volley firing, see "Fire Units," on p. 408.

7.—On the Intensity of the Fire to Be Kept Up.

The intensity of the fire that should be kept up is governed by the time at one's disposal for obtaining the desired result. It should also be remembered that the moral effect of any result increases with the quickness with which the result is gained.

Against a battery of artillery, even beyond 800 mètres, a quick fire should be allowed, while on objects of small depth, only a slow fire.

One to five rounds a minute is quite quick enough for firing in ordinary circumstances, though this may rise to ten rounds a minute just before the time of the final bayonet charge. Sufficient accuracy at ranges over the short distances cannot be expected with a greater rapidity than five rounds a minute.

A very thick line of skirmishers soon creates along its front a cloud of smoke, which considerably hinders its fire action; in such a case, volleys should always be made use of, provided the conditions at the moment permit of their being used.

Rapid firing has a disturbing influence on the men, the smoke very quickly becomes too thick to be seen through, and the direction and discipline of the fire cannot be maintained; hence, rapid firing should only be employed in exceptional cases, and with the greatest parsimony and reluctance.

8. The Attitude of the Men Firing.

The attitude of the men firing affects the efficacy of the fire. At short distances, on the practice range, there is not much to choose between any of the four positions of standing, kneeling, sitting, and lying down, but, as the range increases, the differences in the shooting begin to tell very perceptibly. At the longest ranges the lying-down position gives the best results, and the standing position the worst.

In field firing, in which the attack is carried out as much like reality as possible, better practice can be made at the shorter ranges in the standing and kneeling positions than in the lying down one, because the heaving of a breathless man's chest against the ground in this last position affects the

steadiness of the rifle more than when it is raised off the ground. This fact also suits the moral and tactical requirements of a fight, because it is dangerous at the shorter ranges to let attacking troops lie down, as it not only tends to destroy the offensive spirit required for an energetic attack, but also it may not be possible to get the men to rise again, especially if they have suffered much. But in order to allow of upright troops reaching an enemy's position, it is essential that the enemy must first be demoralised before the assault is made, so as to reduce the efficacy of his fire.* The upright position, however, suffers most from fire, and the lying down position the least. Hence on the defensive or during the preparation of the attack, when the troops are more or less stationary, the lying down position would always be used, except in a flat country, when men lying down cannot, as a rule, see anything to fire at, especially if the enemy is kneeling or lying down also, and he is beyond the short ranges. The attack can safely use this position to within about 600 yards of the enemy.

The kneeling position is very fatiguing if used for any length of time, and so it would only be used during a short halt in an advance when one does not wish to let the troops lie down. This position would be taken up when the lying down position is given up, and it would be used to within about 300 yards of the enemy.

The sitting position is a very good one, and is not nearly so tiring as the kneeling one, but the men cannot readily take it up or get up from it. It is far more suited to the defensive than to the attack.

The standing position is the best for the actual assault, during which very short, if any, halts are made.

Men cannot fire rapidly when lying down, but this position allows of a more frequent use of rests for the rifle, by means of objects on the ground, than any other position. Resting

* A German officer criticising the above paragraph writes, "There is one thing in which I cannot agree with you, that is, to fire at short distances in the standing position: even if the moral power of the defender be shaken, he will still be able to deliver a very heavy fire, and if you do not allow the men to lie down, they will do so without orders, which is still worse. Besides, the dangerous zones will be far greater in firing lying flat on the ground than in firing standing. Also at long distances it will very often be impossible to see the objective while lying on the ground." However, the experience of the Franco-German and Russo-Turkish wars is that when the enemy is demoralised, his fire at short ranges, however heavy it may be, will do relatively little damage, from its going high.

the rifle on such supports is, as a rule, favourable to efficacy of fire, but any decided advantage by so doing can only be obtained from troops who have been trained to it.

9.—The Observation of the Results Obtained.

The German regulations say that the strike of the bullets and the effect of the fire should be carefully watched with field glasses, in order to rectify the sights, and to increase the efficacy of the fire. When several elevations are being used in combination, every effort should be made to try and diminish the number of them by an accurate determination of the range. The value of knowing the range, and of only using the one elevation best suited to it has been shewn in Chapter X.

Intermediate elevations to those marked on the backsight can only be usefully employed when the ranges are known, and the observation of the results easy.

In observing the effects of a fire, the direction of the wind must be taken into account, and it will often be advantageous (especially when on the defensive and in firing from entrenchments) to post observers to one side of the line of fire, who should communicate with the men firing either by signals or relays of messengers. Such observers should bear in mind the following instructions laid down in the French regulations:—

"It will often be useful to regulate the fire practically by some trial volleys, and to watch the effect with the aid of glasses. At first, a sight for a less distance than the estimated one should be used, which is afterwards increased by 100 yards at a time until the right range is found.

"In observing the points of impact, or the strike of the bullets, it is necessary to consider that, in a well-regulated fire, half the bullets will fall on each side of the object. The dust produced by the bullets in advance of the object is therefore not a proof that the fire is too short; while the absence of dust in a favourable soil for observation is a certain indication that the fire is too long. The beaten zone will begin at least 100 yards in advance of the object with firing executed at ranges over 800 yards. (See Chapter IX. for the reason of this).

"On undulating ground, the presence of a depression (the bottom of which cannot be seen into) in front of the object, may make the observation of the strike on the ground very

difficult, and therefore the determination of the sight to be used. If the bullets strike in the depression of the ground, no dust can be seen by the firers, which might make them think the elevation used is too high, while in reality it is too short.

"When the men for observing the fire are placed very far out of one flank of the body of men executing the firing, a too short fire, and good in direction, will appear to fall to the left of the mark for an observer on the right, and to the right for an observer on the left.

"Conversely, a too long fire, and good in direction, appears to fall to the right of the mark for an observer on the right, and to the left for an observer placed on the left.

"These deceptive appearances must be taken account of in the appreciation of the strike of the bullets on the ground."

10. When men in movement may fire.

The question of allowing men to fire while moving does not mean that they are not supposed to halt to actually aim and discharge the rifle, but what it does mean is that these halts are very short, lasting only just long enough to take aim and release the trigger before the movement takes place again.

The preparation for the assault having been completed, the troops to carry it out must now advance. There is no doubt that the advancing troops must use their fire when within the short ranges, but there is some doubt as to whether they should halt at all before that and fire.

"Distant firing and frequent halts are not good for preparing the troops for the offensive, because it breaks their dash, diminishes their ardour, and causes them to be too attentive to their losses, which are always deadly at the halting places, whose distances may be exactly known to the defence."

Further, as an enemy's fire is only efficacious when the distances are exactly known to him, and as experience shows that the greater part of the losses suffered by the attack, occur at the halting places, one of the greatest safeguards of the attack is to move forward so as to constantly alter the range, and hence, after the preparation is completed, the attacking troops should move forward as rapidly as possible to the short and decisive ranges.

We will first consider the moral side of the question, which has already been referred to in Chapter XII. General

Brialmont writes, "When men hear the bullets of the enemy hissing past them, and see their comrades falling around them, they fire in order to conquer their emotions, or to try and forget everything, using a full foresight, and often not aiming at all, or even bringing the rifle to the shoulder. 'The instinct of every man, says Napoleon, is not to allow himself to be killed without defending himself.' If the soldier, at this moment, is not allowed to fire, he 'would try to save himself by moving forwards or backwards,' while, if he fired accurately, he would soon destroy the enemy, '*Fire*,' as Col. A. Du Picq has judiciously observed, in his *Etude sur le combat*, '*is the safety valve of the emotions*.'" And again, "It is certain that even with trained and disciplined troops, a fire while in motion will have little accuracy after any rapid movements to within a short distance of the enemy; but under these unfavourable circumstances any kind of fire will not have much efficacy. Hence preference should be given to that kind of fire which least delays the advance and sustains the *moral* of the men; and this, undoubtedly, is a fire while in movement."

Thus it is judicious to forestall the desires of the men, during their advance, and to direct them into a useful channel, by allowing them to fire a few rounds while moving forward, under the strictest control, so as to ensure efficacy of fire at the same time. We have seen that both Germans and Russians suffered severely when they attempted advancing against an enemy without firing, while their losses decreased when they fired, as they approached the enemy's position, by the demoralization their fire caused among the opposing troops.

But as a control over the fire cannot be so well kept up while the men are thus in movement, they should only be allowed when any real effect is required, to fire in this way, *in a serious manner*, when control is no longer possible, *i.e.*, at under 400 yards from the enemy.*

Again, even allowing that while advancing the ranges are constantly decreasing, and therefore the probable efficacy of the fire increasing, such fire during movement cannot be so efficacious as a more stationary fire at even longer ranges. Hence men should only be allowed, when a serious result is expected, to open a powerful fire while moving at the short ranges

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* See last footnote on p. 453, as to how the fire during movement should be carried out in the advance to this short range.

only and when an independent fire can give an efficacious result.

When a rapid fire is required *at close ranges*, especially in the standing position, when the bayonets are fixed, and when the front is covered with smoke, many writers recommend that the men should fire from the hip, while holding the rifle horizontally, and they assert that good results can be gained by doing so. They consider that to train men to do this well is only to forestall what they will do in reality, because then, especially young troops unaccustomed to war, when close to the enemy, will neither adjust their sights nor aim, or even bring their rifles to the shoulder, while to try and make them do so will only make them lose time, and even expect from them an impossibility. In all ages and in all armies it has been noticed that troops fire high at short ranges, and the advocates of firing from the hip, with the rifle held horizontally, assert that this is the best way of keeping the fire low, thereby gaining both accuracy and rapidity. Firing from the hip is no innovation, as it has been practised in the past by some of the Continental armies.

But to be able to get an effective fire from the hips, it is necessary that the recoil should not be too great, and as the recoil of the Martini-Henry rifle is very excessive, it is doubtful whether it can be judiciously employed in this way, though the men are certain to try to do so, from their shoulders beginning to suffer after 30 or 40 rounds only have been fired.

11. The Number of Rounds to be Fired at Each Halt During an Advance to the Assault.

Granted, that the troops moving forward to carry out the final assault are allowed to fire during the advance, what number of rounds are they to expend until they come within the short ranges? Much, of course, depends on the available supply of ammunition. At about the range of 250 or 300 yards the men will be engaged in a rapid independent firing, which may last four or five minutes, and during which upwards of 40 rounds will be expended. After that they require at least twenty more rounds to consolidate a success or to cover a retreat—that is, at about 300 yards from the enemy, each man ought to have 60 rounds on his person.

Suppose the advance to take place from 800 yards up to 250 yards from the enemy, or over 550 yards before the critical period of rapid firing begins.

If the enemy is very demoralised, and the effect of his fire poor, then the advance may be made without a stop, and it would take some seven minutes to cross the 550 yards at the rate of three miles an hour, and as men running forward in turn, singly or in groups, to fire cannot well expend more than two rounds a minute, they will fire at least fourteen rounds in this time.

If the enemy's fire is still efficacious, the advance will have to be made by successive rushes of alternate companies in larger units over a space of 50 yards at least. Troops advancing thus would make ten successive pauses between 800 and 250 yards, and it would be during these pauses they would fire. The length of these pauses should be as short as possible, in order to give the attack all the vigour and dash possible, and because the halting places are dangerous spots, as most losses occur at them; but, on the other hand, they must be long enough to allow of the advance of the rear echelons being covered by fire, and for the men of these echelons to get into position and to open fire. Most writers agree that one minute should be about the average length of a pause, during which about three rounds may be fired, after adjusting the sights to the range. Consequently, in such an advance from 800 to 250 yards, each man would fire 30 rounds, requiring that the troops when they began to move forward to an attack should each have in their possession 90, or, allowing for bullets dropped, 100 rounds on his person.

12. When the Bayonet Should be Fixed.

It has been found that when the bayonet is fixed on to one side of the rifle, it causes the fire to go to the same side and rather lower than before, and therefore, theoretically, for a given range, aim must be taken rather higher, or a higher elevation must be used. But practically in the excitement of battle, and from the agitation of rapid movement, this result will have the effect of keeping the fire down, which cannot but have a great influence at the shorter ranges over which the assault is made.

The moral effect of fixing bayonets on approaching the enemy is very great, and as the men should fire while advancing to the assault, the bayonets should be fixed at about 300 yards from the enemy's position, just before this assault is begun.

The soldier should have thoroughly impressed on him that the fixing of bayonets in action is a sign to him that the time

has come when it is more dangerous for him to retire than to advance, and that if he advances without hesitation the enemy will certainly not wait to cross bayonets with him.

Fire-Units or Groups.

Fire-units are necessary for two reasons.

1. To get the maximum efficacy of fire a large number of men must be brought into the firing line, and their fire must be concentrated. But a dismounted officer's control cannot be felt over a very wide front in action, and hence the firing line must be divided into fractions which form the *fire-units.*

2. In obtaining the number of rifles required in the firing line they must not be pushed in without order or organization, else control will vanish. For this purpose, regular organized units only must be put into the line at a time, and the number of rifles must be counted at so many *fire-units* or *groups*, and not as so many men simply.

These units may be of various sizes, and should invariably be sub-multiples or fractions of the regular tactical unit—the company. Another point is, that these sub-units must not act independently, or else we run a risk of losing power of control, and of the great effect of concentrated fire.

To get the greatest number of rifles into play, the men must be placed in line in single or double rank; but long lines cannot be commanded by voice, and also the ground rarely lends itself to their movements. It is very important to remember that the power of directing the fire depends more on the front occupied by a unit than on the strength of this unit in men. The longest effective line that can be commanded by voice or whistle, by a dismounted man, even at a distance from the enemy, is a front of about fifty paces. This is about the maximum front over which a dismounted man's control can be felt in action, which gives fifty rifles in one line, or 100 rifles in two lines. An exact front of 50 paces would not, of course, be taken as the fire-unit, but the nearest organized tactical unit whose front most nearly coincided with this distance would be so taken.

If we employ fewer than fifty men at long ranges to form a fire-unit, we run the risk of losing the great effects which a concentrated fire is destined to bring about, and besides, the control of the firing would fall into more hands than necessary for such a fire.

The smallest permissible groups of men should be such as to prevent the control of the firing from falling into the hands

of inexperienced leaders. The fewer the groups or units, the easier is the direction of the fire controlled, but the harder they are to command individually.

It is very essential that the important duties of the command of each unit (*i. e.*, the direction, kind of firing, judging the distances, &c.) should, as long as possible, be carried out by officers, and not by the non-commissioned officers, who should see that the men conform to the officers' orders, and should transmit these orders along the line. These are most important duties, and must not be neglected for more ambitious ones.

Taking an English company at war strength, or about 100 men, these, if extended at one man per pace, as would be the case in a decisive fight, would cover 100 paces, which would give two fire-units of fifty men, or half a company each, under an officer.

As the enemy is approached, the difficulties of control and command increase, but by this time the objects to be fired at have been more clearly indicated and impressed on the men, and hence the fire-units may now be reduced in size to twenty-five men, or one quarter of a company each, each under a sergeant. This shows the necessity of having non-commissioned officers trained to lead in action.

Further, it is highly necessary that the men should be trained to work in groups when at a distance from the enemy, and that their independency of action is only to begin when control is no longer possible; that they must do so because it is best for the mutual good of the whole, and to obtain the best effect of their fire by concentration; this can only be done by fully impressing on the men by practical experiments the inaccuracy of independent fire at ranges beyond 400 yards, when these have to be guessed, and that this can only be corrected by their voluntarily placing themselves under the nearest leader to obtain the required efficacy by concentration of fire. This is particularly necessary when fresh supporting troops arrive irregularly in line; they should be taught to place themselves under the commanders already in the front line, and not to look for orders from their own officers only, unless they have been moved as a complete body into a gap.

As we still get nearer the enemy, the larger organized units are broken up, from the difficulty of controlling fire, but the shorter the range the less important is concentration, and thus smaller groups are permissible; but *groups of from* 8 *to* 16 *men each may be considered the minimum and maximum numbers*

respectively for effective fire. Under a close fire a single man cannot look after more than 16 men at the most in extended order, so as to see that they are carrying out exactly the orders of the battalion officers. Smaller groups than of about 8 men would split up the commands too much.

Men lying down can only be in one line. If we are not opposed to modern weapons, as in savage warfare, the men may kneel or stand in close order, and fire in two ranks, which gives the real maximum amount of fire for a given front, but against modern weapons only half this real maximum amount of fire is attainable until the actual attack takes place, which presupposes that the demoralization of the enemy has been effected, or else the men would suffer too much.

We may take a front of 50 paces as the front of the maximum firing-unit under one man when at a distance from the enemy. In close order in two ranks this would give a maximum firing-unit of 100 men or an English company.

Some experiments that have been made officially in France since 1878 have shewn "That individual firing, as far as accuracy is concerned, is superior to volley firing; that volleys by groups (of about 12 men) are superior to volleys by sections (50 men); and volleys by sections to those by half-companies (100 men). But it must be remarked that the differences are so slight as to give none of these kinds of fire a marked superiority over the others." This official statement has, however, been disputed by individual writers. An anonymous French writer, whose *brochure*, *Le tir de l'infanterie aux grandes distances*, has been much quoted, writes: "The best volleys are those fired by groups, but the maximum effective of the body firing ought not to exceed 100 men in two ranks. The more the fire-unit is reduced in size the better is it in the hands of its leader, who can better look after it, while the men can hear him and execute his orders better. The regulations wisely order the commander to give the word '*Fire*' in volley firing, when he sees the rifles steady; that is when the men are ready and have finished aiming. But the simultaneous readiness of the whole unit will be harder to obtain, as there are more men in it; if the command '*Fire*' is given before they have all aimed, there will be many shots fired wide of the mark; if he waits longer, he will fatigue those ready. . . . Group volleys can be executed with the men in two ranks or deployed. The same can be done with volleys from demi-sections (25 men); but if these are deployed, the

front will be more than 30 yards. It is not possible to execute good volleys with a larger body of extended men."

General Brialmont states that the fire of *pelotons* (80 men) gives better results than the fire of companies (250 men). "This difference can be explained by the fact that in firing by *pelotons*, the soldier, finding himself placed under the immediate eye of his leader, keeps greater calmness than when firing by companies, during which the multiplicity of orders trouble, not only the subordinate leaders, but also the men; by which often a badly directed and inaccurate fire is obtained." Again, "The weaker the unit which fires the volley, the more efficacious is the supervision of the leader, and the more sustained is the attention of the men."

Thus, small groups are the best to use, in order to gain the greatest result from the fire. But the precaution given on p. 398, with regard to pauses, must be all the more carefully adhered to as the fire-units become smaller.

Even if the French official conclusion, that volley firing is rather less accurate than a controlled and steady individual firing, is correct, yet at all ranges beyond the short ones, volleys are preferable, from the moral results and power of control they give, while the difference in accuracy is most likely to vanish in the battlefield, from the ranges not being known, and from the excited state of the men.

When firing with two sights, alternate units of whatever size they may be, or half of each unit may each fire with a particular sight. When firing with three sights (*i.e.*, at ranges over 800 yards when the distance is estimated by eye), it will be best to tell off a third of each unit to fire with the same sight. This can be done easily, as the enemy is still more than 800 yards off. Whole groups and not alternate men should use different sights, so that their commanders may more easily see that their orders are being obeyed.

Hence it is most essential that each fire-unit should have a leader to control and direct its fire.

The position of each fire-group or unit must be looked upon as that of a gun in a battery, or as a battery in a long line of artillery. The orders for the direction of the fire are passed down the line to the leaders, or told them before the action is fully committed, *i.e.*, what they are to fire at, the number of rounds, the rate of fire, the kind of fire, the sight each is to use, &c., and any other such orders, and then the leaders order their groups or units to fire as commanded, and see it carried out. The fundimental rule of artillery action

of massing the batteries and concentrating the fire in the earlier stages of the fight, applies equally well to infantry—mass the fire units or groups and concentrate the fire on the important points of attack.

This sub-division of duties is a most important principle, which has hardly yet been fully recognized or taken its proper place in the English army. No work of any kind can be carried on successfully except by a regular distribution of the work to organized bodies or groups under responsible leaders. This refers to any kind of work carried out by any sized body of men. An army must have its front sub-divided and distributed to army corps, that of army corps to divisions, that of divisions to brigades or regiments, that of battalions to companies, and so on. It is the only way in which any duty can be effectually carried out.

Every progress in the perfection of the rifle will more and more assimilate the conduct of its fire to that of artillery. Infantry officers, to thoroughly understand the proper way of using infantry fire, always remembering that while artillery moves it is useless, which is not the case with infantry, should study artillery tactics, and how its fire is controlled and directed in action. Each rifle in a fire-unit or group must be looked on as a gun in a battery; each fire-unit as a battery in a long line of artillery. Orders for the direction of the fire must be given to the commanders of the fire-units, through the regular leaders in the chain of the military organization, who in turn communicate the orders to the men and see them carried out.* Thus, and thus only, can infantry fire reach its greatest possible efficacy in the field, and the waste of ammunition be reduced to a minimum. Equally with this must every means be studied of allowing ranges to be quickly ascertained with the greatest accuracy possible. The artillery rule of massing batteries and concentrating fire, applies with full force to infantry; and artillery, like infantry, when at too close ranges to carry this out, fire directly to their own front, independently and rapidly and then only. The growing similarity in the field between the practice of infantry and artillery fire, is one of the most remarkable facts in the progress of modern fire tactics. This is in every way to be desired, as it will cause infantry officers to study artillery, and appreciate its value and strength.

* At the closer ranges, officers cannot move up and down the line giving orders, and so the men and group leaders should be trained to pass orders along the line.

For further remarks on the tactical use of these fire groups in action, see Chapter XVI.

RÉSUMÉ.

In conclusion, we may quote the following from the *Revue Militaire de l'Étranger* (1881):—"The regulation of fire in Germany is based on the following principles:—

"1. Above 440 yards no result is to be expected from isolated shots, because the errors in judging distance are greater than the depths of the dangerous zones. As the skill of the marksman cannot counterbalance this uncertainty, the Germans do not employ picked men to open fire.

"2. Fire-action, according to German views should always make itself felt in the shortest possible time; it should be powerful and unexpected. The Germans, therefore, condemn a *deliberate and continuous fire*, and adopt the contrary method, that is, *short periods of powerful fire*, separated by intervals of more or less duration.

"3. The direction of fire in Germany rests with the captain, though there is a growing tendency to make over this direction to the section (zug) leaders.

"4. *In principle*, firing is to be commenced when on the offensive at 440 yards, and on the defensive at 770 yards from the enemy, *when the action has been prepared by artillery*, and in all cases when it is a *decisive action*, and not a demonstrative or delaying action. It is understood that should there be no artillery, infantry must prepare its own attack at longer ranges. The same rule holds good in cases of an inferiority in artillery.

"5. To obtain a moral and material superiority, do not hesitate, when on the offensive, about the necessary expenditure of men, and get close enough to the enemy to be able rapidly to inflict on him the amount of loss required to break down his resistance.

"6. Use different sights in combination, so as to compensate for the errors in judging distance, as well as for the motion of the object, the state of the atmosphere, and the slopes of the ground near the object.

"7. Use rapid independent fire sparingly.

"8. Always decide, before opening fire, how many rounds to expend, taking into consideration the available supply of ammunition.

"9. In action, keep control over the fire as long as possible; *endeavour to do so always.*

"10. Avoid squandering the fire, which is the result of a too frequent change of the objective aimed at.

"Finally, the Germans have no great partiality for fire beyond 1,300 yards, or for indirect fire, in field operations.

"To sum up, it seems that the fire-tactics of the German infantry in a future war may be sketched as follows: the infantry will only exceptionally take part in the preparation of the fight, which is entrusted to the artillery; and in doing so, will act by means of the fire of masses directed on objects specially remarkable or important which may be visible within 1,300 yards.

"After the artillery preparation, the battalions of the first line, which may be most favourably placed, will advance at a brisk pace up to effective range of the enemy, *i.e.*, between 700 and 400 yards. The companies in front will reinforce their firing lines with a second section (zug), and will open against the enemy a vigourous fire, divided by periods of silence. They will then advance by rushes of 50 yards, and by echelons, with a front equal to that covered by a battalion.* The men will throw themselves flat on their stomachs, and immediately re-open fire as before. The third zug of each company will reinforce the firing line, and be replaced by one of the companies in the main body, which will have followed the movement of the extended line. These companies will close on the fighting line, and the whole battalion, after a last discharge of rapid fire, will hurl itself, with levelled bayonets, drums beating, and loud hurrahs, on the position of the enemy.

"This is, it will be observed, the traditional Prussian 'Vorwärts,' with some concessions allowed to fire-tactics.

"It is probable that, in siege-warfare, the Germans will make use of *indirect* fire, even up to distances corresponding to the extreme graduations of the sights. Long range infantry fire is capable of producing very serious results in fortress warfare, especially in attacking *forts d'arrêt*. The supply of cartridges is unlimited, ranges can be accurately determined, range tables and auxiliary points of aim can be used; the skirmishers can find support for their rifles, and having almost nothing to fear, since they should have thrown

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* That is, of two companies, since each battalion throws forward two companies, and keeps two in reserve. This advance, by rushes, may also be executed by alternate half-battalions or companies, but the breaking up of the firing-line should not go below this limit.

up cover, will be in the best possible position for delivering accurate fire. In short, the men are in a situation almost similar to that in which the experimental practice fire is carried out on the ranges; and, consequently, it would not be surprising if results should be obtained which approach those obtained in experimental firing."

From the foregoing pages, we cannot but be deeply impressed with the importance that is attached to infantry fire in the gigantic armies on the Continent, and with the minuteness and completeness with which the subject has been studied by them. Can we say the same in England? With pain it must be said that we are a long way behind other nations in the matter. As far as individual skill is concerned, our men, it must be owned, in spite of our oft-repeated catastrophes in the field as regards musketry fire, compare most favourably with the soldiers of other armies, but they outstrip us alltogether in fire discipline, direction and control. *The secret of the failure of our musketry fire in the field is that fire discipline, direction, and control, are practically unknown among us.* Concentration of infantry fire or the necessity for it, are not even hinted at in any one of our regulations. A certain amount of control is certainly aimed at in volley and mass firing having been instituted to a small extent, but there has not been, until lately, a single word in our regulations as to their uses, the ranges at which they are to be used, or anything to guide an officer, nor even the results of any experiments or data on such kinds of fire have been given which could guide him to a decision.

We have not yet got rid of the notion that the accuracy of the independent fire of the individual soldier must be looked upon as the criterion of the effective fire of the whole mass. *The independent fire of individuals in the field is of little, and we may say of no value, beyond* 400 *yards; the only really effective fire is that which proceeds simultaneously from a great many rifles directed on the same point*, that is from concentrated fire. Again, pauses in the firing are very necessary, and the possibility of these pauses being obtained, whether by limiting the number of rounds to be fired, or by using a shrill whistle as the signal to cease, depends entirely on the men, non-commissioned officers, and officers having been trained to it in peace. This "fire discipline" cannot be improvised on the battlefield, it can only be obtained by constant practice in peace times. The method adopted in England, of keeping the fire under control by the leaders naming the men, or files,

or ranks who are to fire, cannot be maintained at short ranges, and is ineffective at long ranges; and, by such a method, the suddenness and offensive character of a controlled, intermittent, collective firing is lost, as well as the possibility of shaking the moral force of the enemy, which the sudden loss of a number of men is most likely to produce.

In every way our fire tactics have been bad, and before we can hope for real success in this direction, our officers must have given them, in authorized regulations, clear ideas upon the principles to be employed in directing and controlling the firing line, and for obtaining a fire discipline sufficiently strict to ensure attention and obedience on the part of the men to the orders of their officers, even under the disturbing influences of battle, and, further, to make these regulations of any practical value, constant practice must be made with them.

It is with these objects in view that the education of soldiers in their annual training should be directed, and not with the sole object of gaining a high figure of merit at target practice with the number of cartridges allowed to be annually expended, which has been the curse of the English system. Instruction in individual firing should only be carried out with the chief object of teaching men to utilize all accidents of the ground for cover and as rests to their rifles, and when thrown by themselves or on their own resources, to choose rapidly the object to fire at, to calculate the distance from it, and to judge whether the distance is within the limits within which a single shot may be expected to yield a result (*i.e.*, 400 yards at the most), to choose the elevation to be given, according to the apparent distance of the object, to profit by the moments when the object is visible, and finally to accustom him to regulate his own movements with the rapidity and direction of the advance.

It may be considered that fire discipline, direction, and control are not required in small wars against savage or uncivilized nations. This is a great mistake. The nature of the enemy and his weapons may govern and change our tactical formations, but never the fire discipline, direction, and control, which alone can assure the fullest efficacy of the fire being attained under any conditions.

With an enemy unarmed with modern weapons, or unskilled in its use, closed formations may be retained, from the great advantages of the control and the moral support they give the men, and volleys may be used up to a much shorter range, but otherwise the fire tactics described in the

foregoing pages can alone develop the full efficacy of the fire.

General Skobeleff, who commanded the Russian troops sent in 1880 against the Akhal Tekkes, a Trans-Caspian tribe, who had hitherto successfully defended themselves against the Russians in their stronghold of Geok-Tepe, fully realized the necessity of his officers retaining complete command of the fire of their men. He several times specially recommended volley firing, even at short ranges, and then after the instructions already given on pp. 375 and 376, adds, "That is why I cannot urge too strongly on commanders to have the fire of their men under control, and in order that this grand maxim may be a reality, and not merely empty words, is necessary that the commander of every unit should know how to make the hearts of his soldiers beat in unison with his own before the battle.

"He must have his troops completely in hand at the critical moment of action, and they must be in his hands an instrument which serves him to express with a supreme energy, his thoughts, will, and feelings."

These are the ideas of one of the most successful generals of modern days, on the subject of fire tactics against uncivilised tribes. The value of these instructions to us is, that they apply with equal force to our troops, engaged, as they constantly are, in small wars against uncivilised nations.

Let us turn to our own experience with our present fire discipline, direction, and control. The Boer war showed us the absolute failure, as could be expected from the foregoing pages, of our system of relying on the independent unconcentrated fire of individual men. Can anyone assert that the result would have been the same if our men had been taught and accustomed to place themselves under the orders of the nearest officer or non-commissioned officer, that their fire might be rationally and effectively concentrated, and if the officers and non-commissioned officers had been accustomed to such a responsibility, and able to direct and control the fire? Doubtless our tactics were bad in every way—frontal attacks against a determined enemy, skilled in the use of his rifle—but the greatest cause of our failure was the want of confidence the men had in their own individual shooting as compared with that of the Boers. Had the fire of groups of men been concentrated at ranges over 400 yards, over which independent fire is valueless, this want of confidence would not have been felt nor helped in the final disaster.

In Ashantee, our men in the bush fighting, sometimes fired

away 100 to 120 rounds with independent firing with apparently very small result. That is, they fired away more ammunition individually than in some of the most hotly contested European battles. This was only short range firing, and such a number could not have been spent had the fire been controlled.

Take again a more favourable case. In Afghanistan our troops, as a rule, opened an independent fire at ranges between 700 and 900 yards, as we had not then (1878-79-80) any such thing as "fire discipline" in our service, and killed very few for the number of rounds fired. One notable instance was at Dek Sarak, when 28,000 rounds were expended on 50 killed at ranges under 400 yards. 200 of the enemy were really killed that day, but 100 were shot down by a *single volley* from one company at about 100 yards range, and another 50 were killed in a cavalry charge. The remainder of the ammunition was expended on 50 killed. All this firing was at the shortest ranges, and, except the one volley, was a purely independent fire. In this action there was no fire discipline, control, or direction, officers were to be seen taking rifles from the men and making practice for themselves. The result was that the whole of the ammunition with the force was fired away, and the troops had to retire back to camp for want of ammunition, followed up by the enemy the whole way.

One of the most successful actions in the Afghan war was the fight of Ahmed Kheyl. Here the men kept their heads, had confidence, and drove off the enemy with considerable loss by independent fire *at very short ranges*, but even then, some of the enemy succeeded in reaching the bayonets of our men. Breech-loading rifles, if properly employed, can do better than that. Still it may be said, that if the enemy's attack had not been so sudden—it came like a surprise—that better results would have been got. General Stewart had just drawn up his leading brigade in one line without any reserves; he had intended to wait for his rear brigade, some miles behind, to come up to act as a reserve, and then to attack. But the enemy suddenly surged down and were driven off. It was all over in twenty minutes.

When our troops were shut up in Sherpur, on several occasions when independent fire began it increased to such a pitch that neither bugle nor voice could be heard, and the men did not stop until they had fired the last round they had on them. The enemy did not mind this fire; but when volley

firing had to be resorted to in the end in order to maintain control over the men, the enemy were invariably seen seeking for a safer position.

At the disaster of Maiwand, the uncontrolled independent fire of our troops failed to stop the onrush of the closed masses of the enemy, and had no effect on their artillery. Who can say that even with the defensive tactics we employed, so bad against an Asiatic foe,* that the result would have been the same, had we had in our army such a system of fire tactics as has already been indicated.

In Egypt in 1882, complaints invariably came, after every action, of the bad shooting of our troops, and why?—because it was independent unconcentrated fire.

In nearly all our late actions in the Soudan, both in 1884 and 1885, our firing was of the wildest description,† and by no means produced the result that should have been gained had our troops been trained to a good system of fire tactics, and to fire discipline. Twice our squares were broken, but this it must be said was due more to faulty tactical arrangements, and to the opening of the square by the troops themselves than to any fault of the rifle. Thus, at Tamai, the enemy had only twenty yards to rush over before reaching the already opened out leading square, and, consequently, the power of our rifles could not be brought into play. At Abou Klea, the skirmishers on foot in front of the square masked its fire, and the enemy arrived at the already opened out square, with these skirmishers. At Tamai, the rear square had a clear field of fire of 500 yards, and only volleys were fired from it, and the consequence was that with the control and discipline maintained over the men by so doing, none of the enemy were able to cross the fire-swept ground.

It was thought that from the extended order of fighting, which the modern breech-loader necessitates, the troops would require less training than formerly, and that, because of the rapidity of fire of modern weapons, partially trained and imperfectly disciplined militia, volunteers and raw levies would also be more reliable. But actual experience in war has shewn that this is very far from being the case, and that the fire discipline, direction, and control, which the use of

* As General Roberts said "When you meet an Asiatic, go for him, and when you have him on the run, keep him so."

† The fire was so wild that the helmets of the front rank men were often blown off by the rear rank men, and some state that more serious consequences occurred in some cases.

the modern rifle requires for the ammunition to last out, and for obtaining the maximum effect of the supply carried, are more difficult to carry out, and require more peace training than the old drill in close order which muzzle-loading rifles permitted.

Immediately after the war of 1870-71 it was generally thought that the greatest independency should be given to the individual soldier in his actions, but this idea soon died out abroad, while it has ever since been retained in England. *Mutual, and not independent action, is the secret of success in war*, and for mutual action to exist, there must be discipline, direction and control. The word "independent" should be cut out of every regulation and drill-book. Every action can be classified under "individual" (which does not necessarily imply independency), and "mutual" action. The independent training of men is an evil that cannot be too strongly repressed; present conditions require the men to be trained to work mutually in groups under a leader, and not independently. The advantages which a firing-line, divided into groups or commands, has over a continuous firing line, with each man working according to his own lights, are:—

1. It enables a better control to be maintained of the men, so that they are kept better and longer in hand.

2. It enables a concentrated fire to be kept up, even at the shorter ranges, and on the objects required to be fired at.

3. The pauses, so necessary to enable control to be kept up, are facilitated.

4. It conduces to a more rigorous execution of given orders.

5. It helps to avoid waste of ammunition—the group leader having the power of moderating the fire according to circumstances.

6. It permits of a more rational utilization of the cover given by the ground, and of a more energetic advance in the attack.

7. It gives to each man a contact with his comrades in the group, which increases his feeling of security and confidence, by the moral protection it affords.

8. It presents to cavalry a series of organized groups, quickly formed, and capable of sufficient resistance.

9. It allows of volleys being executed at much shorter ranges.

10. It allows of orders being more easily passed along the firing line.

By "groups" it must not be thought that a closed body of men is intended—the group may be extended. The word "unit" perhaps more fully expresses its meaning.

The leaders of these groups, in the final stages of the fight, are the officers and non-commissioned officers, but the latter have, when the enemy is still distant and the combined groups are large, their special invaluable duties in the "control" of the fire, and so they must never presume to take separate command of a group unless they receive the order from an officer, who finds the control getting too difficult to maintain, or if the officer is killed or wounded.

The men in peace time must have a full and clear conviction impressed on them of the value of mutual action, and of the uselessness of independent action, for it is only by so doing that they will have the discipline to voluntarily place themselves under the control of the nearest leader, whoever he may be.

The independent firing of the French in 1870, and of the Turks in 1877 should be taken to heart by all, as a warning of how not to act. The men knew their rifles could carry long distances, and with little regard to aiming or to range, they fired away in the direction of the enemy, without guidance or control. Although heavy losses were thus inflicted when directed on large closed bodies, yet such firing never beat off a determined attack in open order, and it is liable, moreover, at the most critical moment, to cause troops using it to run short of ammunition, as so frequently happened to the French, necessitating of course their retirement. The Germans on the other hand, when on the defensive, never opened fire beyond a range of about 400 yards, and yet their fire, steadily and well delivered—the result of stern discipline and training—was invariably successful.

PART III.

CHAPTER XVI.*

TACTICAL DEDUCTIONS.

The German regulations state that: "The science of leading masses of infantry consists in suitably employing their fire by concentrating it according to time and place, and in throwing disorder, by this fire, among the enemy's troops."

General Lewal writes: "The manner of disposing infantry on the battle field, of conducting a cavalry charge, or of placing batteries, is a direct corollary of the effects of fire."

All history shows the following main principles, governing the tactics to be employed in any war, to be unchanged by time:—

1. That, in all times, those who had the greatest mobility and who knew best how to make use of it and of their fire, had an incontestable superiority in the fight.
2. That a relative increase of artillery has generally denoted a bad infantry.
3. That the progress in the armament of infantry is the principal cause of the successive reforms in the tactical formation of troops for fighting
4. The weapons of one army determine the formations required to obtain the best results from them.
5. The weapons of the adversary determine the formations required to render their power as feeble as possible.
6. Discipline, previous training, and custom, are prime factors in the tactical methods of procedure on the battle field.
7. Victory can only be assured by the demoralisation of the enemy, caused either by the infliction of losses, by an effective fire, or by the failure of his ammunition, or by the moral effect of superior numbers, superior armament, out-flanking him, &c., &c.

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* A considerable part of this chapter is taken from a pamphlet written by the Author, entitled, *The Late Battles in the Soudan, and Modern Tactics: A Reply*, sold by Gale & Polden.

8. Victory is only secured by actual proof of superior strength, shown by the obtaining possession of the ground decisively held by the enemy.

The consideration of the tactical formations and procedure required for the attack and defence, when opposed to modern rifles in the hands of trained troops, requires that we should approach this extremely important subject in the spirit pervading the following extract from the *Wellington Prize Essay* of 1872:—

"I am not urging that any principle that we have adopted from our experience of the past should be held to be sacred on that account. The experience of the past, on which it is founded, must be carefully examined. Whenever we find that the conditions have so changed that the evidence is no longer good, it must be ruthlessly rejected. All modern circumstances must be carefully taken into account. No maxim or tradition ought to be allowed to stand, simply because it was applicable formerly."

In his *Études de Guerre*, General Lewal has made a very true complaint that the movements of armies in the theatre of war are studied more than those of troops on the battle field, *i.e.*, strategy more than tactics. "However, it is tactics which gains battles, and exercises by them a direct influence on the destiny of States." Even at the end of the most brilliant strategical manœuvres it is necessary to fight, and "it is only the gain of the battle which generally justifies the skilful manœuvres carried out by men of genius." Few officers are ever called on to command strategical units, whilst, on the other hand, *every officer* ought to know, on the day of battle, how to employ, in the most judicious manner possible, the men, arms, and ground, put at his disposal. Hence, the subject of *tactics* should be the principal object of military study in an army, especially as good tactics may save a bad strategy, while the most brilliant strategical combinations must fail if battles are lost.

In the following pages we propose to confine our remarks to infantry principally, because infantry on the battle field, whether it gains or yields ground, irresistibly draws the other arms with it in its advance or retreat. A study of any battle, especially of the battle of Sadowa, in the Austro-Prussian War of 1866, will give a striking proof of this truth. We see here that a defeated force, in spite of the most heroic efforts of a good artillery or of the vigorous charges of a brave cavalry, loses the battle by the inferiority (moral or

material) of its infantry, while a good, brave, and well disciplined infantry even with a poor artillery and badly used cavalry, can be successful.

It is useless to seek for details of tactical procedure, suited to modern conditions, in the days of the muzzle-loading rifle and smooth bore artillery. Hence, we cannot even go back as far as the Crimean war for this purpose, except to prove one thing,—the impossibility of a long rigid line of troops being able to advance, as such, over any distance to the attack.

The campaigns of 1859, 1864 and 1866 furnish us with no real deductions for tactical formations, although they give additional proofs to the now fully recognized principle, that before the bayonet assault can be delivered, the enemy must first have been demoralized by an efficient fire preparation. In the latter war the Prussians had such an immense superiority in armament as to render comparisons of little avail.

The Franco-German war of 1870-71, simply startled the civilised world with its rapidity, with the enormous number of combatants required for modern war, with the boldness, not only of the strategy, but also of the tactical formations adopted, and with the dissolving effect of the breech-loader on any kind of closed formation, line or column, at ranges hitherto deemed quite safe.

The French, in this war, had the better rifle, but were much inferior as regards numbers, organisation, training, discipline, and administration. Neither side, however, employed any of the definite fire tactics described in Part II.

In 1866 the eyes of Europe were opened as to the power of the breech-loader, at all events, at short ranges. The Prussians partly saw its true power, and reduced the size of their columns of attack to that of company columns of 250 men each—so that they might move more easily, while offering a smaller target to the enemy. But the necessity of obtaining all the cover possible from accidents of the ground by the use of very small units and extended formations was not as yet fully realised. When the war of 1870 began, skirmishers were still looked on as only a means to prepare the way for the final assault, which was to be carried out by company columns of attack. No one yet dreamed of carrying out an attack from first to last with lines of skirmishers only.

The battles of Wörth, Spicheren, and the fighting round Metz soon convinced the Germans that when opposed to

modern rifle fire in the hands of trained troops, the day of "columns of attack" was past;* that extended formations were required in order to enable the troops to move over the fire-swept zone with the greatest rapidity, to obtain the fullest advantage from the cover afforded by the ground, to lessen the destructive effect of the enemy's fire during an advance, and to enable the attack to arrive without annihilation at the decisive ranges; that the skirmishing line, instead of being an auxiliary, was the principal means of offence and defence; that bodies in rear must simply be considered as feeders to this line, and that in place of the old close columns of attack, physically breaking the power of the enemy, it was necessary to substitute *successive lines of attack for carrying out an offensive assault after the power of the enemy has been broken by the fire of the leading line.*†

The duty assigned to the reserves of a battalion by English writers on tactics, and which is laid down in our drill-book, of finally forcing an enemy's position in conjunction with the troops already extended, is not in accordance with war experience. As Colonel E. Clive, Grenadier Guards, said, in 1878, in a lecture he gave before Lord Wolseley and a number of other distinguished English officers.

"As I read the military histories of past campaigns, the part that reserves have to play is quite different. It is that of carrying forward the wave of attack, and not of making the final rush in line, though the latter was the duty of the reserves when attacking muzzle-loaders."

The false duty, mentioned above, assigned to the battalion reserves by the English, especially when a system of attack is based upon it, or even affected by it, contains a great element of danger, because it may, and probably will, indispose commanding officers to expend the battalion reserves, when necessary, from the thought that if they are once thrown into the fighting line, they have no troops available to drive the enemy out of his position, and *the result of this will probably be long, halting, indecisive attacks, incapable of driving an enemy from his position, demoralising to the men, and inviting defeat.*

It seems strange that now, in 1888, it is still necessary to point

* "All writers who have seen anything of recent fighting, appear to be agreed that an attack in column is a thing no longer possible."—(*Wellington Prize Essay*, 1872.)

† Thus practically substituting an "open column" for the old "closed column" of attack.

out that an attack against the modern rifle has never been carried out in the above manner. Colonel E. Clive, in the lecture referred to above, pointed out that the lesson gained from the wars of 1870 and 1877 was, that direct attacks can hardly ever succeed, except at a most tremendous sacrifice. So that, though the suggestion, that the companies of a battalion are sufficient and likely to shake an enemy, may be a good one to instil into troops in view of minor combats, yet it is not a proper axiom in the higher military exercises, because this is talking of shaking the enemy with a force of two men per pace. The attack is far more serious than this, and in ninety-nine cases out of a hundred, the first as well as the second line will have to be expended before the enemy is shaken and the time has come for the final charge. In all the accounts of the wars of 1870 and 1877 we invariably read of the final decision being made, not along the whole front, but at the decisive points or localities, with "great swarms," "dense clouds," "thick masses" of skirmishers from eight to sixteen men deep. General Skobeleff, after the Russo-Turkish war, expressed his opinion that "the only formation in which troops can successfully assault entrenched positions is in successive lines of skirmishers."

The facts stated in Parts I. and II. have given us data on which we may base our tactical deductions for the future. *The object of all tactics is to obtain victory by the demoralisation of the enemy*, and we can have nothing so demoralising as a well directed and terrible fire. Thus by an efficacious fire we ensure the demoralisation of the enemy, and, therefore, *by an efficacious fire we ensure victory*. In the present chapter we cannot pretend to deal with the whole question of tactics, and the moral elements which affect it; of course, an enemy can be made to retire by threatening his line of retreat, or he may do so from having expended all his ammunition. Such cases we cannot deal with, and all that we can touch on is the tactical procedure that will best ensure a maximum of efficacy for the fire.

The animal instinct of man is that of self-preservation and avoidance of danger. But by discipline and maintenance of control over the men, this instinct can be completely over-mastered. The same can be done by moral influences, such as love of country, enthusiasm in the cause, love of glory, desire for distinction, &c., but discipline and control are the two immediate factors we intend only to deal with here. Custom or habit is another prime factor in war. And it is a recognized fact that men who are thoroughly accustomed by practice to

do certain actions in ordinary times will do the same in moments of great mental strain.

"The best infantry are those who fire the best, most to the purpose, and who, while producing the greatest useful effect, consume the least ammunition," and so every soldier should be thoroughly taught how to obtain from his rifle the highest results it is capable of giving, by a good method of instruction and by constant practice. It should always be remembered that *a fire is only terrible when it is well directed.*

History furnishes many examples of the brilliant results obtained by a well commanded and executed fire, and of how a body of men is only powerful by its fire-power *when the men keep their calmness and presence of mind.* One of the most certain pledges of victory is efficacy of fire, and this can only be obtained by men who do not get too excited to ensure it. Therefore, we must seek the means of allowing men to preserve their moral forces, and also to fire well and be under control as long as possible in action.

These means lie (1) in *a good organisation*, which ensures the necessary command over the men; (2) in *a strict discipline*, which ensures the necessary obedience and suppression of their animal instincts of self-preservation; and (3) in *sound and constant practice*, which ensures the men acting from habit, in a manner they ought to do, in moments of the greatest mental strain.

"The condition which ought to rank before all others is to obtain a superiority of fire over the enemy. It is necessary to make everything give way to this requirement. The victory is at this price." Napoleon I. wrote: "Fire is everything, the rest is but of small account." General Lewal writes: "Fire is the great, the principal, and almost the only force in battle; the shock is only a secondary incident. All efforts ought to turn towards the good employment of fire. . . . We are compelled to deduce this consequence, that a rational tactical disposition consists in augmenting the effects of one's own fire on the enemy, while sheltering oneself as much as possible from that of the adversary."

We have seen that the fire of a number of men must be more or less concentrated, according to the range and the dimensions of the objective, in order for it to be efficacious, and that this collective fire necessitates control and command over the men. Hence to obtain this requirement we must, in the first place, look to the organisation of the men, for control can only be maintained in its fullest sense so long as the organised tactical units are maintained.

In order that a collective fire may be possible at ranges over 400 yards, and that the rules for using different sights may be carried out, it is absolutely essential that the men in the firing line must be organised in recognised fighting groups. This is also necessary in order that volley firing, the importance of which is now fully realised, from the control and power of command which it gives over the men, and the moral force that it maintains, may be effectively carried out. In order not to leave this very necessary system of grouping the men to chance, and in order to impress on the men the immense necessity for it at all times, all Continental powers have instituted a recognised group organisation in the constitution or organisation of their company units, and which they expect to be maintained under fire as long as it is possible to do so, in order to keep up the full power of command and control over the men to the utmost, to utilize their fire-power to the greatest extent, and to minimise the evil arising from the *mixing of the larger units in the firing line* as far as it is possible to do so.

The question of "the mixing of units in the firing line" is a problem which most English tacticians have, as a rule, failed to grasp satisfactorily. The words "mixing of units in the firing line" are indefinite; they may mean that (1) the individual men of two or more units are actually mixed up on the same front so as to form an incoherent mass incapable of control, or they may mean (2) that the firing line is formed of a greater number of units, side by side, than those with which it started, but each on a smaller front. The first meaning is indeed to be deprecated and prevented in every way, as it would entirely destroy any power of control over the men or their fire, but, considering that a firing line has to be reinforced in order to make up its losses, and to give it a forward impulsion, it is very clear that the first meaning ought not to be attached to the above words at all, but that we ought to accept the lateral grouping of units, expressed in the second meaning given above, as the only solution to maintaining control over the men and the fire in the firing line, and not to include it in the words "mixing of units."

The actual mixing, in the first sense given above, of the larger tactical units, cannot be avoided, but that of small groups can be, up to, at all events, the close ranges, where independent fire is permissible. To maintain the control and direction of the men and of the fire in modern fighting, when any reinforcements are required, we must seek to prevent the

mixing of small organized groups under regular leaders by increasing their number on a given front.

Continental nations are agreed that a group of 16 men, at the most, is the largest unit that one man can look after in action under fire, that is in seeing that his orders as to the object and point on it to be aimed at, the sights to be used, number of rounds to be fired, &c., are carried out.* This number, therefore, constitutes the maximum strength of the "fire unit," while the minimum strength may be taken at about half this only, so as to prevent too great a multiplicity of such units. In companies of about 250 men, two groups form a squad; two squads, a section; and two sections, a half company. This group system in the company organisation does not exist in the British Army, although it does everywhere abroad, and this omission is the one defect in our present organisation, for, as we shall seek to prove, *this group system is the essence of any modern attack formation.*

The "section" system, lately introduced into the British service, does not entirely fulfil the conditions and requirements sought to be laid down in this chapter. A section at war strength would consist of from 25 to 30 men, which is far too great a number for one man, the section commander, to look after and control under fire. Hence, in future, when we mention "the group system of attack," the English system is not supposed to be included in it.

If it is ever to be introduced into our service, the *normal* group organisation that should be aimed at might be, that our small companies should consist of groups of 8 men each, *i.e.*, two fours, made up of one corporal, or old soldier, who would act as the group-leader, and 7 men. One of these latter could, if thought necessary, act as ammunition carrier, who would carry out his duties as long as possible, so as to allow the other men to enter the final stage of the fight as fully supplied as possible, after which he would join a group in the firing line, if he cannot find his own. About 6 of such groups, each under a group-leader, would form a half company of 50 men, under two sergeants and a lieutenant; which would make the company about 100 strong, with 1 captain, 2 lieutenants, 4 sergeants, and 12 group-leaders, besides the usual administrative staff, buglers, &c. The company on parade would be sized, numbered, told off, &c., as usual, into half companies, sections, and fours, and each

* The Germans usually employ groups of only eight men each; ten of such units forming a "Zug" or a third of a company of 250 men. The maximum strength of a group in the German service is 12 men.

section would then be divided, as far as possible, into groups of 8 men each, and a leader appointed to each*. The left hand group of each section may have to vary in strength from 12 as a maximum to 6 as a minimum, it being made a rule that no group is to exceed 12 men. *But for such an organisation to succeed it is essential that the men, from the time they are recruits, should be trained to it, by being made to work in groups, under group leaders, in their squad and company drills, as well as when working in the battalion.*

We must not now run away with the idea that all has been done that can be, when this group organisation required for battle has been made to enter into the organisation of the company, as has been done in every European army but our own. Any such system of organised groups will, at a certain period of the fight, be dissolved on the battle field by the enemy's fire; all the small organised tactical groups will, sooner or later, be broken up from losses, from the inevitable drifting of the men to the right and left, and from the unavoidable mixing of the larger units. In *The Frontal Attack of Infantry*,† by Captain Layman, we read:—"In an offensive engagement, however, after a few minutes (within the short ranges), there are no longer any decided (*i.e.*, organised) groups. . . . Here and there, in the vicissitudes of the fight, new groups are formed . ." The minimising of this evil can only be sought for in the training which the men have received in peace time. Every man should be taught and fully impressed with the idea of the uselessness of independent individual action at anything but the shortest ranges, and of the immense value of mutual action, even at these shortest ranges, when possible, and that consequently he should always voluntarily place himself *under the orders of the nearest leader* for control and guidance, so that the greatest good for the whole may be obtained.

Colonel L. Hale has pointed out that the narrow basis of

* In the first edition of this work it was suggested to place two groups or a section under a sergeant, and two sections under a lieutenant as permanent commands, but on reconsideration, the Author has altered this. The reason for this is best given in the words of Col. Home in his *Précis of Modern Tactics* (p. 212) in reference to such a system:—"If any of these commanders are killed the confusion must be great," as a change of commands would have to be made throughout the company; "the division is carried too 'far.'" It is better for the captain to superintend the whole of his groups, assisted by his officers and sergeants, as in the German service.

† This pamphlet was written in 1873, before the system of fire tactics already explained had sprung into existence, and before the group system of fighting had reached its present development.

personal and individual attachment "is all very well in theory, but it is utterly vicious in practice, . . . whereas, we ought to seek to establish in the confusion of battle, a feeling of universal *camaraderie;* soldiers under fire should feel that it does not matter two straws whether it is their own personal comrade and friend whom they are to assist and to whom they can turn for help, but that so long as the man near them is one of their own army, it is him they must help, it is he who will help them. They will not find their own company officers there; these will have fallen, their battalion will be led by a company officer, their sergeants will be leading companies, and in their difficulties they must follow the nearest leader."

Captain Layman, referring to non-commissioned officers as group leaders at the short ranges, writes:—"The importance of the non-commissioned officers depends perhaps less upon their command of appointed groups than upon the influence insured by their position, experience, and matured character, over the skirmishers in their vicinity."

Thus, after providing for a group system in the original organisation of the company, to be used as long as possible, we have done all we can do if we train the men to the idea that, when the organised groups, are broken up, they should voluntarily form themselves into groups, under the nearest leader, to whatever regiment or corps he may belong, in order that the greatest control, power of command, facility for giving orders, and the utilisation of the whole to one purpose may be obtained, and also that a collective and controlled fire may be possible, in order that the best use may be made of the fire, and that any waste of valuable ammunition may be avoided, by preventing a useless, independent, unaimed rapid fire at ill-judged ranges. The importance of this cannot be exaggerated. All military authorities are fully agreed on the influence which custom or habit has on the action of men, and they consider that the instinctive nature in men, of unconsciously acting in moments of great tension and of high mental strain, according to a well-practiced custom, may be fully relied on in battle as an aid to tactical procedure, even when the men are under a very heavy fire, causing them serious losses. The experience of every war has frequently confirmed this fact in a most marked manner, and, indeed, we can see it in many actions of our daily existence.

The fire-groups, advocated above, which they in reality are, must now be looked upon as the guns of a battery of artillery. The firing should not be continuous, or else the fire

will soon get out of control, and will not cease until the last round has been expended, besides which it will also lose the moral effect of concentration and suddenness. In the intervals thus caused in the firing, the orders are passed down the firing line as to the object to be fired at, the number of rounds to be expended, when the fire is to cease, and the advance to be resumed, &c., &c. These orders are given in the first place to the group leaders, who communicate them in turn to the men under their immediate command, and see that they are executed as required. When the fire is so heavy that officers cannot move up and down the line giving orders, then the men must pass the word along the line, but for them to be able to do this, they must have been practised at it in peace exercises.

The officers, and even the group leaders, must be constantly on the look-out to appoint fresh group leaders from among the men of the groups nearest them, in the place of those who have been killed, or too badly wounded to continue their duties.

Before going further, it is necessary to point out here that "the assault ought to take place at particular points, and that we ought not to think that every deployment or fight, even an offensive one, should end by an assault. . . . . . The offensive is not the assault, and no one has the right to advance and engage his troops without the consent of the commander of the whole force, or they may act contrary to his wishes. . . . . . The offensive is not forcibly obliged to end by an assault. The assault is only a particular act of the offensive, at a given point and for particular motives."

Until the actual assault is to take place, which it must always be remembered is only one phase of the attack—the concluding one—the rules for the action of artillery are fully applicable to infantry employed as stated above, viz.:—

1. To get within effective range.

2. When once there to move as little as possible until the advance to the assault takes place.*

3. To mass the fire-groups (*i.e.*, guns) instead of dispersing them.

4. To concentrate the fire on the main points of attack.

But as troops must advance to the assault, and as a long fire fight tends to destroy the offensive spirit and to use up ammunition, arrangements must be made to subdivide the troops for preparing and executing the assault in the manner presently to be described.

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* This presupposes a subdivision of the duties of preparation and assault, as advocated in Chapter XI.

Thus for modern fighting small tactical units are necessary, and also a thorough individual training of the men, to impress on them in the fullest manner that *mutual co-operation is the secret of success in war.* Every man must place himself under the nearest leader for mutual co-operation for battle and fire discipline, and for receiving and transmitting orders. Individual action is waste of power, tends to panics, and is in every way to be avoided. It is absolutely essential that every man should regulate his actions by that of his neighbours, and not fight in the manner of savages, each for himself.

Accepting the usual fighting front of a battalion as two men per pace, history shows us that it is impossible to expect to attack and drive off a well posted enemy with such a force alone, and that therefore the actual mixing of even large units on the same front must occur at some period or other of a hotly-contested fight. Brigades and divisions are found to get mixed, in spite of every precaution, and hence, all that we can hope to do is to delay the moment of this unwished for, though unavoidable, mixing as long as possible, and to make such previous arrangements that when the mixing does take place among the larger units, discipline, direction, and control can be maintained over both the men and their fire by means of very small units. The conclusion which every European nation but ourselves has arrived at, in this respect, is, that the solution must be sought for in the organisation of the company, which, as has been already pointed out, is divided for the purpose into groups of 8 to 16 men, each under a recognized leader whom they follow and pay attention to, and whose orders they implicitly obey; and if a man gets separated from his own group he is expected and trained to attach himself to the nearest one; mutual and not independent action is thus taught in every way. It is hoped that by this group system (which has not yet been tested in war), carried out and practised to the fullest in peace time, the evils arising from the mixing of the larger units will be greatly mitigated, while the necessary discipline, direction, and control will be far better maintained than by any method which merely relies on arranging companies, battalions, &c., so as not to intermix—an unsolvable problem as yet. In the group system, instead of the captain having to look after and control a great number of men extended over a large front, which it is not in the power of any man to do properly, he confines his attention to a few group leaders, who in turn, have only a few men to look after; that is, the captain only deals with the group leaders directly, and through them with the men indirectly.

Although Continental officers have recognised the fact that the intermixture of companies and larger units cannot be avoided, and that a mere arrangement of these units cannot prevent its taking place at some time or other, yet they are not in the least blind to the confusion and loss of control it will entail, unless some counterpoise is adopted to prevent or minimise them. This counterpoise is the group system in the company organisation, and given it, they insist that the amount of confusion and loss of control (which must take place in every attack) will be much less than any other system can ensure. *They only lower the unit that is not to be broken up, or intermixed, to the group.* By this system the group is made the true "fighting unit," and the company, a collection of these units. It is by this means, as we shall presently point out, from the reinforcing being effected by the same groups complete, that the fighting unity is thus absolutely maintained at every stage of reinforcement, because the reinforcing only causes an increase in the number of "fighting units" in the firing line, and not a mixture of them.

This leads us to the question of reinforcing the firing line, which must, sooner or later, cause a mixture of, at all events, the larger units. There are two ways of feeding a firing line (1) by flank reinforcing, and (2) by direct reinforcing from the rear. The latter will at once cause a mixture of any kind of units, however small. The men in a firing line ought invariably to advance straight to their front, and not seek for cover laterally,* but the supports and reserves should always seek for cover wherever it can be found, not for their own sakes, but to save men, for the good of the whole. Hence when men in rear of the firing line advance according to the position of existing cover, the drifting is often so great that it is impossible to ensure even parts of companies reinforcing their respective extended portions in front. Troops in rear of a firing line will further involuntarily converge

* A great distinction must be made between the *attack* and *skirmishing proper*. In the former men must never act independently, but always mutually in groups and larger fractions; while in the latter they may have even, at times, almost complete independence of action. In an attack men must be taught to advance straight to their front, and not seek cover to the right or left, and so crowd up some parts of the line without necessity, and leave gaps in other parts; but in skirmishing, where the men are further apart, cover may be so sought for. When masses of men get crowded together under fire behind cover, experience shows that there is great difficulty in getting them to go forward again.

laterally towards the decisive points of the fight,* and to where cover can be obtained nearest the enemy. The truth is that typical or normal attack formations are very good in their way to train officers and men to a normal mode of procedure that should be aimed at, and to ensure steadiness, but they do not represent what has ever occurred, or ever will occur on the battle field, where the fire of the enemy and the cover available will mainly shape the form assumed by the attacking troops.† This fact points out to us one principle that a battalion formation for attack should fulfil, namely, that *all troops required for reinforcing the firing line at the closest stages of the fight should be in complete units, and independent of those in the firing line.* The battalion reserves fall under this condition, and hence they should be formed of complete companies; but the supports, being required for reinforcing in the earlier stages of the fight, should be formed of the same tactical units as are in the firing line, so as to carry out the principle of all modern fighting, that *every commander should have, in his own sphere of action, ample reserves wherewith to carry out that portion of the fight which he himself is directing and is responsible for.*

The flank system of reinforcing depends on the troops in the firing line closing in as losses occur, and fresh troops being pushed into the gaps. We can easily see that if these reinforcing fresh troops are brought up in organised units, that the problem of maintaining control in the firing line, is as nearly solved as it is possible to be. But, at the same time, it is impracticable to expect large units in the firing line to close in under fire, or to bring up large units for reinforcing; and so the only solution is to organise the troops in small units or groups, and for these groups only to close in on themselves, as losses occur in them, and to carry out the flank reinforcing by pushing intact groups into the small intervals so left. This system of reinforcing only multiplies or increases the number of groups or fighting units in the firing line, and quite prevents their mixing, at all events in all but

* Although the troops are attracted towards the sound of heavy firing, yet they spread out when struck by it, and consequently reserves are required to be pushed into the firing line to keep it at the proper density. Where the line is too thick, complete groups should be withdrawn, supplied with fresh ammunition, and sent forward again to any point requiring reinforcements.

† Jomini writes:—"In discussion on these subjects I remark a fatal tendency in the clearest minds to reduce every system of war to absolute forms, and to cast in the same mould all the tactical formations a general may arrange, without taking into consideration localities, moral circumstances, national characteristics, or the abilities of the commanders."

the very closest stages of the fight. This method is the only one used abroad, and was only introduced in 1884 into our drill-book; direct reinforcing from the rear is only permissible (from the confusion and loss of men it entails), when the above system of flank reinforcing cannot possibly be carried out, which would usually be the case when within 400 yards of the enemy, just before the assault takes place. As pointed out in Chapter XIII., it is not probable that any control is possible under this range.

Officers and group leaders must be constantly on the look-out to see when reinforcements are coming up, so as to close in their groups in time. Each group should have a directing file or man, on whom the other men dress themselves, and to whom they subordinate their movements. The position of the group leader will be behind this file, so as to direct his movements, and when the group is closed in, it will do so on the file of direction. The groups should not actually close in until the reinforcements come up, because the more they are extended, the less likely they are to be hit.

Thus, abroad, reinforcing the firing line is effected by organised groups; as gaps occur in the firing line from losses, and from the groups closing in, they are filled up by complete group units being sent forward, each acting under its leader, who looks to the nearest officer in the firing line for his orders. In this way, on the Continent, they claim, by a group system in the company organisation, to have arrived at the best method of maintaining the discipline, direction, and control of the firing line, and to have reduced to the lowest limits possible, the evils arising from the mixing of the larger units, which must inevitably ensue in time. This system, which is being developed to its utmost abroad, puts further in the background than ever, all schemes for preventing such mixing by an arrangement of the companies, and larger units.*

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* In the German Grand Manœuvres of 1884, the German brigade attack formation of 6 battalions was as follows, according to the correspondent of the *Times* of the 24th September, 1884. Two battalions were placed in the front line, and each extended 3 out of their 4 companies on a total front of 800 yards; these companies formed their own firing lines and supports; the supports were 200 yards in rear of the firing line; the 4th company followed 300 yards in rear of the supports, as a first reserve. The third battalion followed the 2 reserve companies at a distance of 500 yards. These 3 battalions belonged to one regiment, and the 3 battalions of the other regiment of the brigade followed much further in rear as a main reserve. This advance in 5 lines does not look like placing the larger units so as to prevent their mixing, and yet, as the *Times* correspondent

If to prevent the mixing of the larger units, we place all the companies of a battalion side by side, and then also all the battalions, brigades, &c., side by side, for the same purpose, we finally arrive at placing the whole force in a single line. Such a course is inadmissible, and hence, placing distinct units behind one another must occur at some point or other; and, if this is admissible for the larger units, there must be even less harm in it for the smaller ones, the men and officers of which know each other very nearly, as well as they do those of their own respective units.

Thus, the two main reasons for the introduction of the group system abroad were, (1) to prevent or minimise confusion and loss of control that takes place when the larger units reinforced one another: and (2), to carry out the system of fire tactics, dealt with in Part II., which have been adopted for many years past abroad, and which have only lately appeared in our own drill-book. But, instead of a small, handy group, we employ the section, which at war-strength (25 to 30 men) would be far too strong for any one man to control, or to maintain a proper fire discipline in it; and, it is too large for reinforcing purposes. Our attack formation leaves nothing to be desired, except a group system of working, to which the men should have been trained from the time they are recruits. At present, our men and non-commissioned officers, and even officers, do not know the true

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writes:—"The principles of these infantry tactics seemed to be at the fingers' ends of every officer: and the men, too, appeared to be imbued with a thorough knowledge of what they had to do when ordered to do it. In no single case did I observe any crowding or confusion; nor could any lady more deftly, easily, or gracefully expand her fan, than did each officer manipulate the column under his command." But then, it must be remembered, that every German company commander has the greatest liberty allowed him in carrying out his orders; yet, even this will not account for all; the key to it lies in the statement:—"The manœuvres of the last few days shewed how careful German officers are in striving to prevent a useless waste of ammunition, and in enforcing what they call a severe 'fire discipline.' Even when file-firing, the men are only allowed to expend 3 cartridges, and then look round for further orders. The better to attract the attention of their men amid the din of battle, all lieutenants and captains are provided with a whistle, and sometimes the field was all alive with the shrill notes of these little instruments, as with the seductive piping of so many bird catchers. I observed that the officers commanding the skirmishing lines always gave the men their aim and range, and they endeavoured to see that their orders were strictly obeyed." A closer inspection would have shewn that these officers worked by organised groups under regular group leaders.

necessity for working in groups. It has not been impressed on them by fire experiments, as is done abroad, and so the working of even our section system is not anything like as vigorous as it should be; and the whole duty of fire direction may be said to be almost unknown among us, as the question of infantry fire tactics has been sadly neglected in England. Our fire discipline has hitherto been of the very worst description, and there has not been a single campaign, made by us of late years, in which numerous complaints have not been made of the wild shooting of our men. It is the fault of not having hitherto had any system of fire tactics, and not of the men themselves; and, now that such a system has been instituted, let us hope that it will be vigorously insisted on, and then, it will be found, that wild firing will cease, or at least be minimised.

It could be easily shown that if the group system were introduced into the organisation of our companies and the training of our men, it would not only greatly increase the efficacy of our fire and tactical procedure in modern warfare, but also in our numerous wars against savages. It is a system eminently adapted for getting the greatest effect from the breech-loading rifle, and will be still more so for the repeating or magazine rifle, the future armament of infantry; and further, when we come to consider that, at the final stages of a modern fight, the firing line is no longer under control as a line, and that the men are only led on by the personal influence and example of the leaders nearest them, we cannot help feeling that *the group system is the essence of any modern attack formation.* It is well known that men under fire collect in groups and look for orders, and hence the group system described above only systemises, utilises, and places under control what men do involuntarily, thus forming a natural course for the instincts of men to move in, instead of trying to force these instincts to run in a direction contrary to nature.

One thing must not be forgotten, that a fight is first begun by an advance guard, and the troops of the main body have to join in, if possible, on its flanks; but often they are compelled to make use of the same ground, causing from the very beginning an intermixture of the larger units, which would be fatal to the maintenance of fire discipline, direction and control, were it not for an efficient group system of fighting, thoroughly understood by the men, and conducted with skill and judgment by the officers.

A consideration of the above system of fighting with modern

rifles cannot but bring to our notice the fact of the very great percentage of British officers—especially senior ones—killed, to men, who, to their honour, bravely met their fate like true soldiers, at the head of their troops in the hour of victory. With reference to this we cannot but recall to our minds a German criticism on the bravery of our officers and men. It is to be found in an account of the Egytian war of 1882, written by Lieut.-Col. Hermann Vogt. We will give the quotation in full, as it is full of import and deep earnestness to us, and thoroughly explains how it is that we invariably have such a high percentage of officers killed and wounded to that of the men. "All the machinery of the War Office* has again proved unwieldy and unpractical. Its influence, which obstructed and narrowed the free action of the army, was scarcely counterbalanced by the inferiority of the enemy, and by the bravery of the British troops. Under three attacks—two of them surprises—the men held their ground for hours against heavy odds, and they charged the earthworks and the death-dealing cannon's mouth without a moment's hesitation. 'The English infantry,' a French general (General Foy) has said, 'is the best in the world; fortunately it is not numerous.' The praise conveyed in this saying is still applicable as far as regards the personal bravery of men and officers. *The latter*, it is true, *treat the Service, even in the field of battle, more as sport for the development of personal courage than as a continuous series of obligatory actions in the interest of a great whole*; but this is the nature of Britons, who cultivate every kind of sport. The following expression is ascribed to the Duke of Wellington—the 'Iron Duke'—that type of all English generals:—'I always found men who followed the hounds brave and valiant soldiers.' This treatment of war as sport serves to explain the want of vigilance in those precautionary and out-post services where that quality is specially required. The knight fights with praiseworthy courage, and then straightway gives way to carelessness and repose. The sustained alertness of outpost duties, from which little credit is to be gained, seems somehow beneath his dignity, and the British have, in consequence, been twice surprised in this short campaign, to say nothing of the numerous attacks of the Bedouins, the object of which was plunder rather than any military object. Nothing but their bravery and the opportune appearance

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* Under civilian control.

of the cavalry saved the English from a check on the 28th August."*

From experience, many can vouch for the truth of the above criticism. But why should not our officers control their instincts, if they are opposed to the requirements of war, just as they expect their men to control their natural desires of avoiding danger? In war the instincts of nature have to be held in the iron hands of discipline; not merely of the discipline of obedience that we only know of in England, but of a higher discipline, which, besides obedience, requires from all a submission to control, and mutual action, and a subserviency to the good of the whole. This is the kind of discipline that exists abroad, but which is almost unknown in English practice and writings. The British nature described above had a free outlet in the days of Wellington, when the bayonet charge took place after the first volley. Then reckless and impetuous bravery told. But in modern fighting a higher moral courage of self-restraint is required, in order to enable a strong control to be kept up over the men until the moment comes for the bayonet charge, when their pent-up feelings may be allowed to go free. We are far from blaming individual officers, all of whom cannot be expected to study every question deeply, but we do lay the blame on our tactical regulations, which, until lately, in no single instance mentioned the necessity of maintaining, in modern combats, a rigid battle and fire discipline for controlling the men in every way, nor the means of effecting this. Even in the writings of English tacticians

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* With regard to outpost and advanced guard duties, there is no doubt that, in our Service, there is much room for improvement in these matters. In the first place, our regulations do not lay such stress on them as those of foreign armies do. In the German regulations we find the very highest stress laid on the practice of the outpost service, from its great value in developing the intelligence and powers of observation of the men. In the next place, the method of carrying out the outpost and advanced guard work, as laid down in our drill-book, is not suited to the majority of cases that occur in war. The pretty fan-like figures shown in that and other tactical English books are rarely to be seen in the field. It is not possible for us to go into the matter fully here, but there are ample competent men in England who could say what should be. The present system of outposts, given in our drill-book, has only been used in investment warfare—an exceptional case—and it is not in any way so fitted for practical field service, as the system of inlying and outlying pickets which it superseded, and which has been invariably used in every war we have made of late years. Another defect in our system of outposts is, that we trust far too much to stationary sentries than to patrolling. This latter system has the advantage of requiring fewer men and, at the same time, keeping them better occupied and preventing them getting careless so quickly.

we only find the subject lightly referred to, and its true importance passed over in silence. On the Continent the necessity and urgency of this higher discipline in war is everywhere impressed in the strongest terms, both in official regulations and by individual writers. It is doubtless to the impetuous personal bravery of English officers that we owe our heavy losses among their numbers. But, in the interests of the Service, we should demand that officers of all ranks should not recklessly expose themselves in the tide of success. If they place themselves at the head of their men when all is going smoothly, their influence is lost when pressure comes. Officers of high rank should be strictly forbidden to recklessly expose themselves unless their troops are wavering and require the impulse and encouragement of the presence of their chief to carry them forward. This moral lever in the hands of officers should not be used too soon or unnecessarily, or else it will lose its strength.

Coming now to the manner in which the larger units will fight in the future, it may be here pointed out that *the method of conducting troops in great battles is governed by very different considerations to those which govern the conduct of troops in the smaller combats made by independent detachments.* For example—

1. The front of an independent detachment is only limited by considerations relative to the ground, to the maintenance of proper cohesion, and to the position of the enemy.	1. In large battles most of the troops have a restricted front imposed by the presence of other troops on either side of them.
2. The rear lines of an independent detachment can outflank the troops of the first line, and hence the attack can aim at tactically outflanking the enemy.	2. In large battles the rear lines cannot overlap the front lines, and hence an attack cannot tactically outflank the enemy, but must partake of a frontal character tactically.
3. With an independent detachment, a flank attack can be arranged for tactically, *i.e.*, on the field of battle.	3. In large battles, flank attacks can only be arranged for strategically, *i.e.*, off the battle field.
4. In independent detachments, the artillery can more or less choose its own positions, and fight on the flanks of the infantry, or in any intervals in the line.	4. In great battles the artillery of an army corps (about 100 guns) takes up a front of about 2,000 yards at least, under the most favourable circumstances, and hence

	artillery must fight on the same ground as the infantry, firing over the heads of the latter. It has no choice of positions, but must make the best use possible of the ground it is on.
5. In independent detachments the troops can be placed and moved so as to make the best use of the ground in any direction to gain the object in view.	5. In large battles the troops must move straight to their front, and they can only make use of the ground lying directly between them and the enemy.
6. In combats made by independent detachments, the opportunities for the use of cavalry on the battle field may be many.	6. In large battles the use of cavalry on the battle field itself is very restricted.
7. In the minor combats conducted by independent detachments, the attack will have most chance of success by skilful generalship on the battle field.	7. In large battles the success of the attack depends more on the best use being made of the physical means of destruction employed, and on the previous strategy that has brought on the battle.

Hence in minor combats conducted by independent detachments, the attack will have most chance of success by skilful generalship (an unknown factor) on the battle field; in large battles, on the other hand, the success of the attack depends more on strategical combinations and on the best use being made of the physical means of destruction employed. Consequently we will principally confine our remarks to what is required for the larger battles, which must necessarily be of a more mechanical nature than the smaller ones, but, from what has been said, we see that we really want two normal formations for fighting, one for use in large battles, in which the front of the tactical units are restricted, and the other for use in smaller fights, in which an extension to a flank can be easily effected.

It is very necessary to try and realize what will be the nature of the attack in the future, and to train our officers and men to the normal types of formation best adapted to it. As Colonel Von Schell says in his "Studies on Artillery Tactics": —

"The history of war shews on every page that we are

often obliged to deviate from normal forms; but, it also shows from time to time, in a very plain manner, that the conditions of the combat would have probably been presented in a very much more favourable manner, if the Commander had tried to keep as near as possible to the normal formation."

Thus, as General Lewal says:—"Normal tactical formations have a real absolute value, provided they are adapted to the configuration of the ground, to the nature, and to the moral situation of the troops,—the three elements which control the action of every good or skilful tactician."

As it is intended to deal with only such questions as affect the efficacy of the fire of the attack and defence, we cannot enter into several important matters effecting modern tactics in connection with the details of the general method of the fighting of the future to be described. Amongst these are the manner of taking up formations for battle (offensive and defensive), for great and small fights; the determination of the fronts of a battalion and other units, for attack and defence; the methods of directing the attack; the position that should be taken up by the commanders of different units; the method of issuing and transmitting orders in the field; the organisation of tactical units to suit modern fighting requirements; the distribution of troops and trains on the line of march, for modern fighting; composition of advanced guards; details of the artillery combat; the armament and use of cavalry; and the method of using advanced guards and outposts, &c.

Having thus limited the field of inquiry, we can now proceed to consider it.

The visible sign of victory to an attacking force is the occupation of the enemy's original position, and this can only be effected by the final charge of masses after they have rendered its execution feasible, by having effected the demoralisation of the enemy by fire, or by having caused him to use up all his ammunition, and so rendered him powerless for defence; the bayonet having no chance against modern rapid-loading fire-arms, well supplied with ammunition.*

* Referring to statistics, the percentage of bayonet wounds to others in war had been:—Crimean War (1854-55), 0·41 per cent.; Italian War (1859), 0·23 per cent.; Danish War (1864), 0·08 per cent.; Austrian War (1866), 0·03 per cent.; Franco-German War (1870-71), 0·08 per cent.; Bosnian Campaign (1878), 0·03 per cent.; Russo-Turkish War (1877-78), no statistics. This shows the superiority of the bullet over the bayonet, and points to the conclusion that such a rigid line, as formerly used, is not required for the modern bayonet charge, which can now only be carried out when the crisis is past. The magazine-rifle in the future will probably take the place of the bayonet as the Boers used their weapons at Majuba Hill.

No assault in modern warfare has ever been carried out by an extended line, properly so-called. In all accounts of the great battles of the war of 1870-71, we read of assaults being carried out at the decisive points by " great swarms," " thick clouds," " dense lines," &c., of skirmishers 8 to 16 men deep, and the possibility of such a feat when opposed to modern breech-loaders, must, of course, pre-suppose the demoralisation of the enemy, or the failure of his supply of ammunition, rendering him in either case incapable of further serious resistance, or of injuring the dense mass in front of him. If neither of these conditions were fulfilled, the assault was invariably repulsed. *Masses are required now-a-days, as formerly, to force a position and to drive the enemy out of it; the extended order of modern warfare is used as a means to collect this mass within assaulting distance; the regulation attack formation is only a basis to start from;* and the loose formation of the thick "line" is, in spite of the immense difficulty of retaining command over the men, now necessary to execute the assault, because no rigid closed line can move any distance without being completely broken up, as seen at the battle of the Alma. Further, if an extended formation cannot carry out an assault it is not good for receiving one, both on account of its weakness and of the want of moral force it imparts to the soldier. *At the instant of contact, therefore, a closed formation of some kind is required, whether in loose or rigid close order, both in the attack and defence.*

The first result of the experiences of the war of 1870–71 was to cause many theoretical writers to assume that, the whole key to the secret of success was to break up an imaginary two-deep line formation at some distance from the enemy; to send it forward in extended portions, while maintaining a fire-fight across the fire-swept zone, in order to reduce the effect of the enemy's fire, to more easily obtain cover, and to secure greater mobility; then, at about 150 yards from the enemy, to reform a two-deep* line again, by the closing up of the rear portions; and, finally, after a short rapid fire, to carry the position by a rapid advance, followed by a charge. *But not one single fight in modern warfare has ever been carried out in this manner, and yet it is the controlling principle of our drill-book.* And further, all past history shows that, at the decisive moment, it is not

* The 30 to 50 per cent. losses which the firing line has now-a-days to submit to, and the fact that men have only a certain amount of "go" in them, which evaporates after a time, does not seem to have been considered in this arrangement.

possible to obtain any such true tactical formation, as aimed at above, with which to deliver the assault, and also that victory depends not so much on the number of men killed or wounded on either side, as in the moral effect produced on the determination of the survivors to remain or advance; that side which has the greatest determination to effect its object, and has still the means of doing so, will win; and hence all regular attack formations can only be "starting," and not "final" ones. In our own late experiences, at Tel-el-Kebir, in 1882, the Highland Brigade is stated to have been formed up in line two deep within 300 yards of the enemy before the assault took place, and yet the entrenchments were reached by a cloud of men of different battalions without any true tactical formation (see p. 463, Vol. XXVII., *Journal R. U. S. Institution*). In the Soudan also, when the bayonet charges were made, tactical formations were at once broken up. At the end of the battle of Albuera, in the Peninsular War, the Fusilier brigade, although it had advanced in a two-deep line, were found to be crowded up four deep in spite of their enormous losses.

Practical war experience has shown, that the power of the modern rifle is such, that a frontal attack against a well-posted, disciplined, and unshaken enemy will rarely succeed. The usual causes of defeat by a frontal attack are, want of discipline and training, and the consequent want of moral force which keeps men at their place in obedience to orders, even when opposed to overpowering numbers; a too great an extension of front; or a failure of ammunition. The uncertainty of long range fire, and the feeling of security which distance impresses, will never cause victory, whatever the opponent's losses may be. No battle has ever been won at long ranges. It is only the shortest ranges possible that are decisive. The problem of how to obtain accuracy of fire at all ranges is comparatively easy for the defensive; but the attack, on the other hand, labours under the disadvantage of having to combine as much as possible the contradictory elements of rapidity of movement and accuracy of fire, and they can only do this by sub-dividing the duties of preparation and execution, and by advancing rapidly to such short ranges, at which the fire cannot help being efficacious, and consequently decisive, and the problem, for the attack, is how to do this without excessive losses.

The war of 1870-71, besides showing the almost impossibility of reaching this distance by a purely frontal attack, showed

that it was possible to do so by attacking the enemy's flank at the same time. Flank attacks have more chance of success than frontal ones, from the shape of the ground, on which the attacked flank rests, being less favourable for defence than that taken up as the front; from the preparation for resistance being usually weaker on the flanks than on the front; from the moral dislike or feeling of danger inherent in animal nature when danger threatens the flank or rear; and from the terrible effect of an enfilade fire. The sound of firing even on their flanks or rear often intimidates the defenders of a position, and causes their retirement, or at least produces a tendency to do so, readily. It may be laid down now as a maxim, that when opposed to a well-posted and disciplined enemy, armed with the modern breechloader, flank attacks are the only ones that have a real chance of succeeding. Flank attacks of course eventually become local front attacks, but the new front is weaker than the true front of the force. A flank attack, however, can only be carried out by superior numbers or superior generalship.

Besides the losses being less, the results gained from a successful flank attack are usually greater than those from a frontal one, as the enemy is driven from his most favourable and direct line of retreat, supposing him to have taken up a position across this line, as would generally be the case.

Small bodies of troops can be moved easily, and should therefore always attack the flanks of an enemy; and in fact the smaller the body the stronger reason it has, leaving other considerations out of the question, for carrying out a flank attack, because it has not sufficient weight or strength of itself to successfully attack in front an enemy posted in a favourable position for defence. Small bodies of men have no imperative line of communication to be cut off from, as they can live anywhere, and so they can retreat in any direction. But if they do so, and are covering other troops, they should send back word what they have done, and rejoin them as soon as possible for combined action (which cannot be effectively carried out by separated troops), and for replenishing the ammunition expended.

Thus it may be laid down that now-a-days *flank attacks are the main attacks, while frontal attacks are the secondary or auxiliary movements*, and are only made use of generally as a strong demonstration * to tie the enemy's troops down and so to render

* It is essential that this demonstration should be so carried out as to make the enemy stand, and that it should be ready to change to a decisive attack if the enemy offers a chance for its success.

them immobile and incapable of being used elsewhere. But history shows, however, many examples that *flank attacks, without such frontal attacks, are very liable to be defeated, by being out-flanked themselves.*

But seeing that any flank attack upon a position becomes in time a local frontal attack, the following remarks will be confined to the best method of carrying out a frontal attack under the conditions of modern European warfare, and *as the defensive should invariably be looked on as only a preparation for a subsequent offensive* (provided the relative strengths of the contending parties are not too disproportionate), and defensive tactics being simple as compared with those of the attack, the latter only will be dealt with in this chapter.

Any adopted normal attack formation for use against troops, armed with and trained to the use of the modern rifle, requires *amongst other things* the following conditions to be fulfilled:—

1. It should enable the best use of the rifle to be made at all times, and greatest development of fire to be obtained at the decisive moment.
2. It should present the most difficult target to the enemy's fire.
3. It should allow of the best use of cover being made until within assaulting distance.
4. It should afford the greatest mobility possible at all times.
5. It should give the greatest facility for the transmission of orders at all times.

1. The two-deep line formation is undoubtedly the best for obtaining the best and most powerful use of the rifle, but war experience and peace experiments have shown that when opposed to modern rifles in the hands of practised troops, *any closed formation* is inadmissible, from the losses it entails, until the enemy's resistance has been broken, or until he has been demoralised, from its not being able to obtain cover readily or easily, and from the want of power to move, inherent in closed line formations. As columns cannot exist under modern fire, we need not consider the possibility of using them in an attack formation opposed to it. These conditions disappear in savage warfare, in which closed columns can be used for the advance, and closed lines for both the defence and the attack, when this latter is only made over short distances.

2. An extended formation offers the smallest target to the enemy's fire, but if the enemy has no fire power to speak of, close-order formations should only be used.

3. An essential feature of modern fights is the necessity for making use of the cover offered by the ground, in order to increase the effect of the fire of the attack, and to diminish that of the defence. Hence, an enclosed country is favourable for an attack, and an open one for the defence. But in every case, whether in attack or defence, when once the effective ranges have been reached, a clear field of fire must be sought for by the men, in preference to any cover which hides the enemy from view, because at these ranges the greater object is to destroy the enemy, the lesser to protect oneself from him. With regard to making use of cover, this can be much more readily done by extended formations than by closed ones.

4. The best safeguard from an enemy's fire is rapidity of movement to pass quickly over the fire-swept ground, which, at the same time, reduces the efficacy of the enemy's fire, by constantly altering the range. On this subject Von Boguslawski writes: "It is an established fact that the rapidity of advance is a great method of reducing the effects of the adversary's fire. All attacks and movements executed under fire of the enemy should be done at the double, or at least by stepping out, if the nature of the ground, or the fear of fatiguing the troops, prevent this." The greater part of the losses in an action occur at the halting places during an advance. This is another reason for a rapid and continuous forward movement when the advance has been once ordered. But a great and sustained rapidity of movement is, on the other hand, prejudicial to accuracy of fire, as it causes the men to arrive breathless at the decisive ranges, and so prevents the possibility of demoralising the enemy by an effective fire.* It is infantry fire which really decides the issue, though it may be greatly helped by the artillery, and hence great mobility for movement is only required up to the effective ranges, after which the advance must be slower in order to ply the enemy with an effective fire to demoralise him before the final assault is made. On the other hand, any check in an attack reduces the offensive spirit on which success so

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* This fact and others, such as the absence of any definite fire tactics, a smoky atmosphere, and the excitement of the men in battle, all prevent aim being taken, and account for the German artillery often being able to fight the French infantry at ranges of 300 yards, in 1870. Generally, too, the French had been demoralised before the guns had got within this distance. The French are particularly noted for the rapidity of their attacks.

much depends. The latest ideas for obtaining the necessary fire preparation (of both artillery and infantry) with the requisite mobility, will be given presently.

5. The necessity of being able to transmit orders at any period of the fight, and of assuring their deliverance and execution, both for fire purposes and for directing the movement, is so apparent as to make further comment needless. But this transmission of orders can only be effected by maintaining or ensuring an unbroken line of organized groups, or other tactical units, in the firing line, and by training the men to pass any orders down the line during the pauses, when the efficacy of the enemy's fire prevents officers from moving up and down the line.

To fulfil the first four of the above requirements, troops, when opposed to modern rifle fire, must be extended, while, to fulfil the first and last ones, they must work in organised groups under regular leaders. The breadth of a target does not increase its vulnerability, which only depends on the depth, height and density of the target. Hence, an extended line, if thick, is as vulnerable as a rigid closed line two deep, but it is more mobile, can take cover more easily, and can make better use of the rifle during an advance. But the disadvantages of an extended formation, as compared with a close order formation, lie in the greater difficulty of control over the men, and of supervision and command, and in the confusion that ensues during any forward movement, from the mixing of the larger tactical units. As troops, when opposed to modern rifles skilfully used, must be extended, we must try and see how these disadvantages can be reduced to a minimum, and the method now advocated by the best Continental authorities for doing so, have been already stated.

Close order formations are all that are required for use against savages armed with hand weapons, or even armed with rifles, but unskilled in their use, and who principally employ shock tactics; they further give a great moral force and control over the men and power of transmitting orders.* Cover is not now required, and as the men should be formed in line to get the maximum of fire, they can advance in small

* The disaster of Isandlhwana shows how completely we have lost sight of the fact that the necessity for an extended order in a fighting formation ceases to exist when we are not opposed to the modern rifle, and that in such a case closed formations, covered with a few auxiliary skirmishers, or rather scouts, *who should invariably be mounted*, are more than ever adapted for troops armed with breech-loading rifles.

columns (capable of rapid deployment) to within close and effective range, and then form into line to effect the destruction of the enemy by fire before finally closing with him.

Against badly-armed or trained troops who do not go in for shock tactics, a line of groups, or other tactical units, (each in close order), may be used, if the nature of the ground is such as to prevent any more simple form of attack being used.

That troops must be sent over a fire-swept zone in extended portions, when opposed to modern rifle fire delivered by trained troops, is, however, an inevitable fact; but *modern attack formations must be based on the principle, that troops kept in rear are simply for the purpose of feeding the extended firing line in front* in order to keep up its fire power, to carry forward the wave of attack,* and finally, when the enemy's strength is broken and the weak points seen, as will be the case when the position is nearly reached, to carry forward, at these weak points, masses of men, also in extended order if necessary, to break in at them. If it is possible, from the demoralisation, or from the pre-occupation of the enemy in other directions, to bring up the men in close-order formations for this purpose, it will be better, as the men would then be more in hand, and the subsequent and inevitable mixing of the larger units would be reduced to a minimum. *The attacks must be general, the assaults local*, so as to enable the attackers to be superior in force at the point where the assault takes place. Napoleon I.'s saying, that "if you try to be strong everywhere you are weak everywhere," must never be forgotten in any operation of warfare.

Such a method of attack naturally entails a great mixing of the larger units. To mitigate the evils arising from this, the method adopted for years past on the Continent, and which was only last year introduced into our system of attack, is, as we have already pointed out, to make small portions of the firing line close in to a flank, or on their centres, as losses

* Experience shows that, in action, a line of troops pushed out in front has only a certain amount of energy which will carry it forward over a certain space, after which there is a tendency to halt and look to the rear for supports, which, if not sent forward then, may cause the retreat of the foremost line. The supports must be sent forward before the retreat begins, and, being fresh troops, with their energy unexpended, they will carry their line further forward, and it is in this way that the fight in front must be incessantly fed from the rear, and carried forward at the same time.

occur, leaving gaps, and into these gaps the reinforcing or supporting troops are pushed in organised groups or units, at all events, during the first periods of the fight. During the later periods such a proceeding may not be possible, from the loss of leaders and the excitement of the men, and loss of organised control over them; then we can only trust to the discipline and training which the men have received in peace time, to place themselves under the nearest leader, whoever he may be, and of whatever rank or corps, for guidance and for receiving orders that are required to be carried out.

To carry out the attack as described above, every writer of authority clearly lays down that *we must employ small tactical units, like companies, and give to them all the independence permissible, consistent with the general good of the whole, and the object in view.** These small tactical units must be pushed forward as required, but, with great circumspection, for troops once engaged under fire, at even medium ranges (*i.e.* between 400 and 800 yards), can never now-a-days, as of old, be withdrawn and used for other purposes; and, further, troops, once so engaged under fire, can only move backwards and forwards, and not at all to the right or left.† Hence it is the duty of every commander to employ deep echeloned formations, covering an extensive belt of ground in depth, and to retain a reserve in hand, however small, for contingencies; but he must never hesitate to employ it, should the wave of attack cease rolling forward, provided there are other reserves in rear. If not, then only the most desperate circumstances or real signs of the enemy wavering should induce him to sacrifice his last reserve rather than allow the attack to fail; otherwise he must use the reserves kept back to cover the retreat.

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* There has been much opposition of late to the use made of the square formation in the Soudan. The Author cannot help thinking that their use, under the conditions of the present nature of the peace training of our men and of the war, was judicious, considering that English troops are trained to move in battalions, and that any independent action of companies is unknown in our service. In action, especially in savage warfare, the first thing men listen for is a quick decisive word of command, and this can come far better from a company commander than from a battalion commander. Until we change our system of drill in peace time to allowing companies to move with more independence in carrying out battalion or brigade formations, it would be dangerous to begin it in the face of an enemy.

† Except troops making a tactical flank attack, who must wheel or form up, in fractions or as a whole, to the assailed flank of the enemy.

Fewer troops now-a-days are required than formerly to be kept massed in reserve in case of retreat, from the great retaining power of the modern rifle. Pursuits are extremely difficult now-a-days, from the confusion caused by the mixing of the larger units in the fighting line of the attack during an energetic advance under modern fire.* Hence the defeated troops in late wars have usually been able to retire without serious pursuit, especially when even a small intact reserve has been maintained which can hold its own against a disorganised, though numerically superior, enemy. These latter should in any case, for their own safety, halt to reform when the enemy's first position is carried, as they can never know whether he may not have a second line prepared in rear, against which a disorganised advance would be stopped, and the first success turned into a defeat.

The necessity of re-forming engaged troops as soon as the engagement ceases, or during any pause in the fight, is so great in these days of fighting in extended order against an unseen enemy hidden by cover, that it cannot be too strongly impressed on leaders of all ranks. It is only by so doing that command, control, and cohesion, can be maintained, the evil caused by the mixing of the larger units reduced to a minimum, and the moral effect of numbers impressed on the men, who are apt to think their losses greater than they really are. Re-forming the tactical units also has the effect of rendering the men available for use in other directions, which they were not before, and of having them as completely in hand as possible to meet any further attempts of the enemy. These remarks apply to both the attacking and defending troops.

An attack may be divided in four distinct phases, each of which is more or less carried out in every battle in the order given, namely, (1) the reconnaissance; (2) the preparation; (3) the execution or solution, including the bayonet assault; and (4) the re-forming of the tactical units and consolidation of any success or the retreat.

The execution should really be sub-divided into two periods, (*a*) the advance, and (*b*) the assault or attack proper. The *exact* points at which the assault should be delivered can only be determined when the preparation has been completed and the execution begun. The first part of the execution is really

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* At Sadowa, in 1866, the II. Prussian army corps took six hours to pick out its men and re-form before it could pursue.

a feeler for the second part, and, as every offensive movement does not necessarily end with an assault, this latter should never be seriously attempted by any troops without a distinct order from the commander of the whole force, because to make it certain of success, they require to be backed up by large masses of other troops in rear,* for if they are not so backed up, the assault may fail, and the troops making it, driven back, while their retirement is certain to cause that of the troops on either side as well.

The difference between the advance and the assault, and that the former is not necessarily followed by the latter, can be best seen by reference to the proceedings of a siege. Col. Home in his *Précis of Modern Tactics* says, "The attack on an enemy's position is based entirely on the science of the attack on a fortress. A mass of artillery fire is concentrated on certain points; under cover of that fire the infantry advance until checked by infantry fire. Again the infantry fire is subdued by the infantry fire added to the artillery fire of the attackers, a breach is made in the enemy's position, and through that breach a formed body of men is pushed, who make a lodgment there. Such in general terms is the attack of a fortress. Such in general terms is the attack of a position, with this difference, the former is the work of days, the latter that of hours."

The assault is, in a siege, the last act of the fight, and is delivered at particular points on the front attacked, and so it must not be confused or mixed up with the other acts of the offensive, or connected with them as taking place at the same moment. The investment, the parallels, the zigzag approaches, &c., are all different acts of the offensive, taking place at different times and towards different points. These points are determined by the general in command, and it is at them alone that the final act of the assault is made, with all the troops available, and not along the whole front attacked. Hence every offensive movement is not necessarily intended to finish with an assault. This is a very important point for all officers

* "The miserable, doubting, unmilitary policy of small storming parties, on the plea that if we fail we cannot lose many men, causes more mischief, loss and disgrace than any other proceeding in war."—(Sir John Burgoyne). "These words, though referring to assaulting parties at sieges, are just as true of all attacking parties."—(Home). The failure of the English attack on the Redan at Sebastopol, and of the Russian attacks on Plevna, were due to the neglect of the principle of using successive waves of supports to force the assault home.

to bear in mind, and therefore no officer should approach the enemy nearer than 400 yards without a distinct order to do so from the general officer commanding that portion of the line, or unless the enemy is distinctly giving way.

A "German General" writes, "In general, modern fights (as compared with those of the past) are distinguished by three characteristics: 1st. The attack demands a much longer and more careful preparation; 2nd. The assault itself occupies a much shorter time; and 3rd. The result is far more decisive."

The efficacy of a concentrated long range fire, the difficulties of supplying ammunition to troops engaged at ranges under 500 yards, and the moral effect of a continuous advance in an assault without stopping, has lately led to the recommendation of telling off a certain proportion of the troops, with a large supply of ammunition,* to advance, *after the enemy's artillery has been silenced*, to about 600 yards from the enemy,† to prepare the way for the final assault, in conjunction with the artillery, by a long range fire-fight of perhaps considerable duration.‡ These men would remove their valises and entrench themselves. Up to the end of this period the attack acts principally on the defensive. When the demoralisation of the enemy is considered sufficient, as can only be judged by the lessening of his fire, or by its want of efficacy, then a forward movement by successive advances on the front of a battalion if possible, or of companies at the least, is to be made by the firing line,§ with the aid of fresh troops if necessary, to within 300 yards, when the bayonets will be

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* This supply of ammunition is obtained from the ammunition carts of the battalions, told off for the execution of the assault, who do not require more than 70 rounds per man for this purpose alone, and from the divisional ammunition columns. These troops, thus thrown forward, should have, if possible, 180 to 200 rounds per man on their persons, so as to reduce to a minimum the necessity of having to supply them with more ammunition under fire.

† Or nearer, if possible, but not so close as to prevent their being supplied with fresh ammunition, if necessary, or as to entice or cause the men to bring on a decisive crisis which may cause them to recoil, lose moral force, and even draw into the fight the troops in rear before the way for their action has been properly prepared.

‡ "Tedious though the preparation for the attack be, its result is "decided with the speed of lightning."—A German General.

§ The fire being still kept up by men, or better still by entire groups, running to the front in turn and halting to fire, until the line comes up to them, when they again advance and wait their turn. (See p. 386.)

fixed, and a terrible fire poured in. Before this occurs, the circumstances of the fight, which has now reached a decisive crisis, will have pointed out the most favourable points of breaking the enemy's line, and there, after a few minutes of heavy firing, the advance to the final assault must be rapidly made, while still keeping up the fire, in conjunction with fresh troops sent forward from the rear, with ringing cheers, colours flying, bugles sounding, drums beating, and all the pomp and dash of war, without stopping, and without a halt. Over the last fifty yards the charge will be made at the double.

"Formerly the fire-arms were used to induce such a state of things as would make it possible to bring the bayonet to bear. The fact of a bayonet charge then implied that the critical moment had come. Now the rush to seize a position implies that the critical moment *has passed*, or the rush is sure to be fruitless."—(*Wellington Prize Essay* of 1872, p. 86.)

If the enemy has not been sufficiently demoralised by the previous artillery and infantry fire preparation, and by the rapid musketry fire at 300 yards and under, the attack will fail and be driven back.

The demoralisation of the enemy by losses must be effected before the assaulting distance is reached; within this distance the result is far more due to the moral effect produced by an advance of the assailant's masses than to the effect of his fire, as short range fire in action is very inaccurate at ranges over 50 yards, from the excitement of the men. If the enemy is sufficiently demoralised for an assault to succeed, he will retreat, even though an advance be made against him without bayonets. This was exemplified at Majuba Hill, when the Boers successfully assaulted, without using bayonets, a position held by our troops. Within 50 yards the fire of the assaulting troops begins again to be low enough to produce losses among the defenders, and it is probable that the magazine rifle in the future will greatly take the place of the bayonet during an assault. In all the actions in the Soudan, our greatest losses occurred when we gave up firing to use the bayonet. But the bayonet, fixed to the rifle, no doubt gives a very great moral support to the soldier, and will therefore always have its place.

General Hardinge, in a lecture *On the Results of Field Firing in India*,* stated that from the results of field firing carried out in India, it was found that the best effect for the Martini-

* To be found in Vol. XXIII. of *The Journal of the R.U.S. Institution.*

Henry rifle was obtained between the ranges 900 and 600 yards, because the shorter ranges are only reached by rapid advances, and this gain of distance is more than counterbalanced by loss of breath and other physical disabilities, which impair the accuracy of the weapon. Breathless haste may avoid losses, but steady fire can alone inflict it. Speed of movement and steadiness of aim do not go together, and if we try to combine both, we sacrifice both, and as neither can be dispensed with, the only thing is to use them separately by assigning distinct functions to separate troops, some to prepare the advance, some to cover its near approach, and some to reach the ultimate goal.

However men shoot, they will always fire better from a fixed base than from a moving one, although the moving one brings them to shorter ranges, and this is another reason for telling off a certain proportion of the troops to fire from a fixed base during the reconnaissance and preparation for the attack, and with these troops until the final advance takes place the artillery maxim of not moving guns well in action may be adopted with the best effect for ranges over 400 yards.

Such a method also enables us to make use of the long-range power of the weapons now in use. If we do not use them at these longer ranges, we lose the greatest part of their advantage, though this long-range fire must only be employed in accordance with the principles already given in Chapter XI. Fire is everything now-a-days; it is the principle, while shock, though still necessary, is the secondary means, and hence the preparatory action of artillery may be most advantageously assisted by the long-range power of the modern rifle. A preponderance of fire is required for success, either for the attack or for the defence, and to establish this preponderance of fire we must bring into effective play every rifle possible at all stages of the fight. Even the fire of reserve troops must be made use of when possible, like artillery, from a fixed base during the advance, and over the heads of the troops in front, to help to keep down the fire of the enemy. Whole companies in close order might, for this purpose, be brought like batteries, into distant action, as they can then be plentifully supplied with ammunition.

In the advance by successive rushes of alternate units, it is most essential that these units should be such as have *at least* a front of one-quarter that of a battalion. This is very important, for many reasons, which can be best shewn by a reference to some of our fighting in Afghanistan. Besides

allowing our men, in this war, to fire independently, as a rule without any control, and at too long ranges (700 to 900 yards), the firing line, in an attack, was often allowed to advance in driblets of twos and threes. It was quite a common thing to see several men and officers some way ahead of the true firing line, whose fire was thus masked. If whole companies had been advanced together by the order of their captains, it would have made such a really energetic offensive movement as would have added greatly to the moral effect of the advance, both by intimidating the enemy and encouraging our own men more, while it would have prevented the weak-hearted and cowards from lagging behind and shirking their duty. One subaltern per company should be ordered to always remain in rear, to see that every man advances with his company. Capt. May, in his famous *Tactical Retrospect of the War of* 1866, points out that the watching over troops in action is a necessity. "It is not sufficient that the eye of the leader is directed on the enemy; to advance and leave half the men behind on the way cannot lead to any advantage. The company should have an officer in the supernumerary rank, who should be responsible on his honour that he will keep there, and not rush to seek his laurels in the front. Then it will be easy to bring the company full and complete into action."

During the execution of the last rapid phase of the attack (*i.e.*, during the rapid advance over the last 300 yards) the men must never be allowed to lie down, for two reasons: (1) it takes away from the moral offensive spirit, and the men are only with difficulty made to get up again to advance; and (2) according to Continental experience, under the agitation of moving after an energetic advance, fire from a standing or kneeling position is more effective than from a lying-down position. This advance, under such conditions, is now practicable, for the fact that the order for the execution of the attack has been given, presupposes, either that the enemy is demoralised, or that his power has been broken, or that his ammunition has failed, rendering him powerless to defend himself against a vigorous assault, or to injure it sufficiently, by what fire power he has left, to check it.

The *reconnaissance* and *preparation* of an attack are two essential features of modern battles. The reconnaissance is carried out, in preference, by cavalry, and, if necessary, by the infantry of the advance guard, who must, after driving in the enemy's outposts, be extended over the whole front of the enemy's position, in order to cover its own artillery, which now comes into

action, to draw the enemy's fire, and thus to find out the extent of his position, and the distribution of his front line of troops. The preparation for the attack is then carried out by artillery, assisted, if necessary, by infantry

Captain Layman, in *The Frontal Attack of Infantry*, says:—

"We now know what a frontal attack against a position defended with breech-loaders signifies.

"If we have resolved to undertake this task—in any case the most difficult and sanguinary for which infantry can be employed—then the least we can do is to make the most careful preparation, in order to secure the greatest possible chance of success.

"It is not to be accomplished solely by an impetuous rush forward; the greatest bravery can be wrecked in a fire-zone of 1,000 paces. The time which is spent in making good disposition and introducing the attack is never lost."

This time is always to be got now-a-days during the artillery preparatory combat. It is of the utmost importance in modern fighting that troops should be prevented, as far as possible, from hurrying into action in fractions, before the whole force is ready to begin the fight simultaneously, as it only renders them liable to be beaten in detail. In 1870, the Germans nearly met with a disaster at Spicheren through doing this, and at Gravelotte they suffered enormous losses from the same reasons, and also from an imperfect reconnaissance, which caused them to make a very great error as to the position of the French right flank, through which some batteries were silenced almost immediately they opened fire. The German troops at Gravelotte, contrary to the wishes of their Royal Commander, it must be said, rushed into action as they arrived on the battle field, and it is extremely doubtful whether they gained the slightest advantage, or hastened on the final decision by so doing, while, on the other hand, they suffered enormous losses. "A German General," writing about this battle, says "the German commander resolved at all hazards to drive back the French upon Metz, while Marshal Bazaine was bound to hold fast to the only line of communication with the rest of France that still lay open to him. The decisive point of the position, therefore, was at St. Privat, on the extreme French right, by which the last line of communications ran. As the fate of the whole battle naturally turned upon the course taken by events at St. Privat, the desperate fighting and frightful slaughter that took place along the rest of the line was wholly unnecessary, and was

wilfully brought on by the assailants, rather than caused by irresistible necessity." As to the French losses on the left, opposite to where the Germans attacked so unnecessarily and lost so heavily, General Hamley writes, "the Second French Corps on the left of the position was attacked by two, afterwards three, German Corps; and while these suffered enormously, its loss in killed was only 60 men." In addition to these there were only 366 wounded and 195 missing (including wounded and unwounded prisoners.) The fights at Borny and on the Mars-la-Tour-Vionville-Rezonville line, before Gravelotte, were brilliant exceptions to the rule; the French were retiring, and their retreat had to be stopped, at all costs, by the leading troops as they came up until the main body could arrive and deliver a decisive combat.

The following remarks apply principally to the conduct of troops in large battles, where troops have to fight on restricted fronts, and brute force has more to be resorted to than skilful use of ground and movements, on account of the attacks partaking more of the nature of frontal attacks than would be the case in the minor combats delivered by independent detachments. Detachments are more mobile than great masses of troops, and consequently can more easily march round each others' flanks, or arrange for a tactical out-flanking movement.

The infantry may be divided as follows, as a normal basis for practice, if they have to carry out the reconnaissance as well as the other duties or phases of the fight: one-sixth for reconnaissance and covering the artillery, which would be the advanced guard; one or two-sixths more for the preparation, to be sent forward after* the enemy's artillery has been silenced and its own artillery fire has been turned on the hostile infantry; three or two-sixths more for the execution; and the remaining one-sixth in reserve to act as rallying point after, or for completing the attack, or for covering a retreat.

When the preparation is completed from a maximum normal range of 600 yards, the *execution* should be carried out as

* The reason why they should not be sent forward before this, is to save the infantry from every useless casualty until the actual moment of assault, when they will probably have to bear great losses. Serious losses incurred before that moment are of little avail, and therefore to be avoided. If the infantry for the preparation are sent forward before this, the fight becomes simply a prolonged duel of artillery *versus* artillery, and infantry *versus* infantry, exposing the infantry to losses before they need be; so they should wait until the artillery is free to throw its aid into the scale as well, so as to bring on the final decision as rapidly as possible.

already described as rapidly as possible, *the secret of success being clearness of conception, and energy in execution.*

As a line of defence now-a-days consists of a line of detached localities, the actual assaults will be confined to these points, so that, although the troops told off to carry out the reconnaissance, and the preparation are extended over the whole front, yet the troops to execute the assault are not; consequently on the actual fronts of assault a greater relative proportion than five-sixths of the whole force to the total front it occupies, is obtained for the assaulting troops.

The experience of the Franco-German war showed that the attack should have, including all troops and reserves, about 12 to 14 men per yard of front; this allows for the troops required to carry out the flank attack, as well as those to hold the enemy in front. This would give for the attack, after deducting the troops to carry out the flank attack and local assaults, at least 1 man per yard of front for the reconnaissance, 2 to 3 men per yard for the preparation, 5 men per yard for the advance, and 10 to 15 men per yard for the local assaults. The defence should have from 7 to 10 men per yard of front, for any hope of a successful resistance.

During the reconnaissance, the troops should be well extended, simply to draw fire and to cover the artillery, but in the preparation and assault they should be collected in organised bodies, to deliver their fire with the greatest effect, and to enable more control and unity of purpose to be obtained.

The possibility of carrying out the above in its entirety, wholly depends on a properly recognised and organised DIVISION OF DUTIES, both in the upper and lower units of the army. The division of duties and the organisation for it, as far as the lower units have been concerned, have already been touched on, but these cannot be applied to a large force in itself. When large armies are opposed to one another, the front of attack and defence must be divided into sections, the troops in each having their own duties to carry out. Each section will have its firing line, supports, and battalion reserves, if these latter are considered necessary,* and also local reserves if required. Behind these there will be a large general reserve (including the reserve proper) to each army corps front of from 3,000 yards on the offensive to 4,500 yards on the defensive;† the only difference between the

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* In 1870 whole battalions were often extended in the firing line, the reserves being furnished by other battalions in rear.

† These were the usual fronts taken up by the German army corps (of 25 battalions each) in the war of 1870-71.

defence and attack in these respects being that the numerical proportion of the reserves to the rest of the force is smaller in the defence.

The tactical deductions to be drawn from the Franco-German and Russo-Turkish wars, in the former of which the breech-loader was pitted against the breech-loader for the first time, are great and numerous. Some of the facts that these campaigns and subsequent experiments have clearly brought into view are:—

1. The enormous power of the breech-loader at all ranges up to 1,300 yards, but especially at the short ranges under 400 yards.

2. That from 400 yards and under, an upright man can be hit by every shot aimed at his feet with the 400 yards back-sight.

3. The uselessness of individual fire over 400 yards, from the height of the trajectory, and from not knowing the ranges sufficiently accurately, and the consequent necessity of concentrating a number of rifles on the same object at greater ranges than this, to obtain the desired result with the greatest rapidity and suddenness.

4. The dissolving power of the breech-loader on closed formations at all ranges, and its defensive power, when in the hands of unshaken troops, over the open against any attack formation.

5. The enormous losses caused by purely frontal attacks over open ground, and the consequent necessity of an effective artillery preparation, or of simultaneous decisive flank attacks arranged for either tactically or strategically, when opposed to the breech-loader.

6. The necessity of studying the question of the supply of ammunition.

7. The necessity of a group organisation, and of a rigid fire discipline, control and direction, in order to prevent waste of ammunition, and to secure the best effects of the fire.

8. The necessity of extended formations and small tactical units, with an independence of action only governed by the mutual co-operation of the whole, and the general object in view.

9. The necessity of carefully training the men to mutual and not independent action, and under conditions as like war as possible.

10. The necessity of a deep disposition of troops in successive lines, when opposed to modern rifle fire, in order to enable commanders to have some troops in hand to control the fight, as troops once engaged under fire can only move backwards or forwards, but not to a flank.

11. The necessity of a long preparation by artillery and infantry fire before the assault, in order to demoralise the enemy.

12. The necessity of carrying forward the line of attack by successive waves, or rather additions, of skirmishers.

The effect of the introduction of long range fire has been to force the fighting formation to be taken up considerably further off; and thus, if faults are made in the original dispositions, they will be harder to repair.

The employment of reserves will be more difficult. If they are to be preserved intact, they must be kept well in rear, and as a consequence, it will not always be possible to ensure their opportune arrival.

General Skobeleff has laid down that, under modern fire, "The only formation in which troops can successfully assault entrenched positions is in successive lines of skirmishers. The divisional general must be perfectly thoughtless of his own comfort and safety, and put himself between the skirmishers and the reserves, where he can feel the pulse of the battle, and have his troops in his own hand, and judge himself of the moment when the successive battalions in reserve should be sent forward.

"There are in every command a small percentage of cowards who will shirk away at the first opportunity; a certain number of men of rash bravery, who will go too far forward and get killed; and a majority of men of ordinary courage who are liable to waver as the fight gets hot.

"The reserves must be sent in at the moment when the reasonably brave men have been long enough engaged, and have met with sufficient resistance to begin to feel nervous, but before they have actually begun to retreat: and, it is in deciding upon the opportune moment for sending forward his reserves that the art of a divisional commander consists."

But the Russian attacks, it may be said, were nearly always directed frontally against the enemy's position, without a sufficient artillery preparation; attempts to turn one or both flanks of the enemy being very rare.

Modern infantry fire has made flank attacks almost a necessity now, because any frontal attack against an undemoralised defender in position, with a clear field of fire of 400 yards, will be too costly a proceeding, and is only then likely to succeed under such favourable circumstances as are rarely likely to occur.

The employment of reserves will be more difficult. If they are to be preserved intact they must be kept well in rear, and

as a consequence it will not always be easy to ensure their opportune arrival.

The artillery of the attack will be forced further back, or will be obliged to resort to some such expedients as bullet-proof shields.

The use of cavalry charges on the battle field will be still more restricted than ever.

The use of cover, natural and artificial, has been raised to a point of the greatest importance.

For temporising or delaying fights (as in advance or rear-guard actions, or for points against which it is only intended to demonstrate), long-range fire will be particularly suited, and also, it will often be possible by fire from long ranges to deceive the defenders of a position as to the real point of attack, and it will be of peculiar value in a pursuit.

On the defensive, it will often obviate the necessity of occupying points which can be covered by it from the main line, and it will be most useful in delaying an attack by making the enemy deploy early and thus causing mixing and confusion in his ranks at an early period of the fight. One of the advantages of advanced posts is to secure this early deployment and confusion by long-range fire.

One of its most important qualities is the power of using it, when the form of the ground is suitable, both in attack and defence, over the heads of men in front, thus often enabling two or more stages of fire to be used. The terrible effect of such a method is to be read of in the accounts of the battles round Plevna, where the Turks often had two or more lines of infantry, one above the other, causing thereby enormous losses to the Russians.

Long-range fire will be of great advantage to the attack, in turning or outflanking movements, as it will render possible for them to pour in a powerful enfilade fire suddenly on the defensive line, from a much longer range than has hitherto been the case. Similarly, it may be of use to the defence when a turning or out-flanking movement is itself out-flanked.

It will enable a much more powerful fire to be concentrated by a superior attacking force on any point of the defender's line, since troops from more distant parts of the field can take part in it.

Lastly, in the case of troops attacking a position on the crest of a dominating plateau, they may, *perhaps*, be able to sweep its surface for such a distance to the rear, as will render it more difficult for the defenders to bring up supports and reserves to the threatened point.

CHAPTER XVII.

MUSKETRY INSTRUCTION.

In this chapter no attempt has been made to enter into any minute details of musketry instruction, but only the broad principles on which such instructions should rest are discussed.

From the enormous power of well employed modern fire, we can quite understand the vast importance of a *rational* musketry instruction. The two great wars of 1870-71 and 1877-78, in both of which the losing side had the better weapon, have shown in unmistakeable terms that *it is the superior tactical use of the weapon, and not the superior weapon itself that gives the victory.*

A French writer, in commenting on the war of 1870-71, writes:—"The fire of the French infantry was terrible. At great distances they sent out a hail of bullets, which, though fired hap-hazard, did not the less cause much loss. But when this zone was crossed, a relative safety was found; and at the short distances it could be seen, that the German soldier, carefully instructed in musketry, had an unshaken confidence in his weapon, that he made use of it with coolness and method, and therefore with a sureness that the French were far from equalling. With respect to firing, the German infantry had the superiority, which it owed to the long and minute instruction that had been given it in peace time." (See also p. 250). The importance of these words cannot be over-estimated.

The principal instruction in musketry should be such as to fulfil the requirements of the fighting tactics of the day. The fight now-a-days is exclusively carried out in extended order. On the battle field the positions of artillery and infantry are only distinguished by the smoke which rises from behind shelter trenches and epaulments. The only rather more favourable objects, which are now-a-days seen, are the firing line and its supports, when they change position at the double, that is to say, when they make short appearances. To insist on firing little, and only at short distances, on such targets, with the modern rifle, is not reasonable, considering the considerable effect that it can give, at even fairly long ranges, as shown by past experience in the field and on the practice range, even when badly used, provided the required amount of ammunition is available, both as regards place and time.

Besides, the waste of ammunition and the bad employment of fire that has been seen in the past, are no arguments against rapid fire and its employment at long ranges *against suitable objectives*, but show rather a defective application of the fire, and whenever the conduct of the fire has escaped from the leaders, the fault, in most cases, has been from the insufficiency of the regulations on the subject, and from want of fire discipline.

Up to 1870 the accuracy of individual fire at all ranges was considered as the test of efficacy of the shooting in the fire-fight. The war of 1870-71 dispelled this idea, and it was then accepted abroad that individual fire is of little use over 400 yards, beyond which distance the collective fire of masses should be used, and for such a fire to be possible the men must not only be organised in fire-units, whose fire can be directed and controlled by leaders, but they must have fire discipline as well.

The English system of raising the value of individual fire at long ranges far above its proper level, lies at the root of all our failure of musketry fire in the field.

English soldiers have hitherto been taught to fire individually over measured ranges at distances which it is absolutely wrong to do in the field, according to all Continental experiences. 400 yards is the extreme limit for individual fire in the field, when ranges are judged, except against such large targets as would show great remissness on the part of the enemy, and then only for good shots and when the range is fairly well known. The great danger of allowing men to fire individually at ranges much over 400 yards in peace time is that it makes them think that they should do so in war time.

Volleys and mass-firing are mentioned in our regulations, but hardly anything is said as to their applicability, their relative values, the ranges suited to them, or their *raison d'être*. Individual fire is the guiding principle of our musketry instruction, we still seem to adhere to the idea that the criterion for effective fire is the accurate independent fire of individual soldiers.

Accordingly no experiments of any practical value have been made in England, as abroad, from our want of appreciation of the true use of the rifle in war, and hence for nearly all the data that has been given in this book, foreign sources have had to be drawn on.

Musketry instruction ought to be divided into two clear and distinct parts.

(1) The training and development of the skill of the individual man in shooting, or *target practice.*

(2) The instruction of the men and tactical units in the practical employment and conduct of fire, or *war practice.*

It is for a want of recognition of these two clear and distinct branches of musketry instruction that our regulations have failed to be really practical. Our new musketry regulations are an immense improvement, but even in them the Author cannot help thinking that the distinction has not been fully realized. We will deal with each of these parts in turn.

Target Practice.

To effect this, not only must the man be made to shoot over known ranges, but he must be given a stimulus to shoot well, by creating an emulation and competition between men and companies, by rewards* and prizes, by classifying the men, and by punishment in exceptional cases, and the men should always be made to understand what they are doing.

It is very essential that this part of the musketry instruction should be very carefully carried out, so as to gain good results *in order that the men may attain a perfect confidence in the powers of their weapon when well used.*

"The increasing development of the material forces in war, requires a parallel development in the moral forces. In order to overcome, without being weakened, the most difficult phases of the attack, which begins now-a-days at over 2,000 yards, the soldier requires more powerful moral qualities than in those days when the danger only began when he arrived within hearing of the voice of his enemy. Everything that can raise the moral quality of the soldier ought therefore to be maintained and carefully cultivated. In the first place comes the confidence of the soldier in his rifle." Thus no pains should be spared to make the soldier perfectly reliant on his weapon.

Again, it must never be forgotten that *rifles are weapons whose value only depends on the skill of those using them*, and therefore it is highly essential that this skill should be developed to the utmost.

In the German service, gymnastics form an indispensable part of the musketry instruction. The following is an extract

* The best shooting company of a battalion might be given certain privileges.

from a letter written by a German officer to the Author:—"The chief advantage of our instruction is the thorough training. In no other branch of instruction is such a strain put on the systematical and thorough training of our men. Gymnastics are considered quite indispensable to obtain good results. Perhaps it may interest you to see how we carry on our training. At present (January, 1886) the 2nd class shots of my company are firing at 150 mètres at target No. 2. . . . We have target practice once a week, and begin on the day previous with half-an-hour's gymnastics, using our rifles as you use clubs; one hour's aiming and position drills (150 mètres), firing with aiming tubes at 25 paces, and half-an-hour's gymnastics. The next morning we put every squad for one hour through gymnastics and aiming drill. The non-commissioned officer has, on the march to the ranges, about three miles distant, to instruct his men in the use of the rifle, height of trajectory, &c., by sending a few men in advance and ordering them at intervals to advance, lay down, retire, &c., and questioning his men with him as to the sight to be used, range, point to be aimed at, &c."

Naturally a difference should be made between the recruit, who handles a rifle for the first time, and the trained soldier who knows what to do.

From what has been said, the courses for the development of the skill of the recruit in shooting, and for the annual practice of the trained soldier for the same object, might be:

The Recruit.	*The Trained Soldier.*
(i) Preliminary instruction, consisting of:	(i) Preliminary instruction, consisting of:
(*a*) Theoretical principles.	(*a*) Theoretical principles.
(*b*) Cleaning arms.	(*b*) Cleaning arms.
(*c*) Aiming drill.*	(*c*) Aiming drill.*
(*d*) Position drill and firing exercises.*	(*d*) Position drill and firing exercises.*
(*e*) Blank firing.	
(*f*) Instruction firing.	
(ii) Target practice, individual fire only, at 50, 100, 200, 300, and 400 yards, in drill order; 10 rounds at each range; total 50 rounds.	(ii) Target practice, individual fire only, at 200, 300, 400, 500, and 600 yards, in drill order; 10 rounds at each range; total 50 rounds.

* Aiming, and position drills, and the firing exercises are aptly expressed in the American musketry regulations as the A B C of good shooting.

All other kind of firing and judging distances should belong to the "war practices." *Instruction firing* has been mentioned above, but it will not be referred to again until p. 481.

The targets should be those known as "third," "second" and "first-class targets," without figures of men on them; the aim should be taken at a mark in the centre of the bottom of the target with such special elevations (given on a printed table) according to the range as will ensure the bullets striking a central bull's-eye if properly fired, and the hits valued according to their distances from the centre;* the result of each shot to be signalled back; all this being carried out just as is done at present.

From this target practice all classification of shots, prizes, rewards, and returns should be made out. From what has been said in Chapter IX. about the great extent of ground beaten by a collective fire, no attempt should be made to classify individual men by the results of the war practices, as such a classification would be very unfair.

For the development of individual skill in firing we must have competition, with money prizes or rewards of some kind, and punishment. Competition must produce the best individual shooting, as it does the best of anything else. But this competition should be limited to battalions alone, and each battalion should have given it a certain sum of money and other rewards, depending on the number of men trained, to compete for among themselves. The money and rewards should be bestowed at once, and not some time afterwards. By such a method the huge system of checking the returns of the whole army will be dispensed with to a certain degree. It is unfair to say that one battalion is better than another when they compete in totally different climates, conditions, and ranges from one another. No comparisons should be made between battalions, as far as target practice is concerned, but a certain fair standard of shooting should be insisted on which, if not reached, then the training should be continued, and even punishment awarded, provided no physical disability is the cause.†

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* From Chapter III. and IV. we see the uselessness of altering the sights after each shot. The sight should only be altered if the mass of the shots show any necessity for it.

† Physical disability occurs oftener than is usually suspected, as Lord Wolseley said at the R.U.S. Institution on the 26th February 1886: "I think we shoot quite as well as the armies of any other nation. Of course you can teach some individuals to shoot remarkaby well, but

The recruit should be given a rifle as soon after he joins as possible, in order that he may get quickly accustomed to it, even before his actual instruction begins. It should not be forgotten that, especially with recruits, the great art of instruction is to dwell *forcibly* on things *really essential*, *moderately* on things *important*, *lightly* on things *nearly indifferent*, and to *omit* things of *no practical use* to the man.

A recruit should first be told and have his mind strongly impressed with what a rifle can do at any given distance by being shown, and then he should be made to make it do what he has seen it can do, if properly managed, and if, after firing a certain number of rounds, he fails to reach the required standard, provided he has no physical disabilities, he should be made to pay for the extra ammunition and have his leave and other privileges stopped.

Target practices for both the recruit and the trained soldier should only be carried out during the most favourable months of the year for good individual shooting.

In the German service every care is taken in the individual education of the soldier, especially in whatever affects his *moral qualities*. Thus in the German service everything is done to prevent the men feeling that firing is an unpleasant duty. For example, it is laid down that, "if a man gets agitated at the moment of pulling the trigger he must not be allowed to fire a shot; if he cannot acquire sufficient calmness to fire, he should be kept back until another day." The Germans never attempt to hurry through the instruction of their men (see Note on p. 512). "Slowly and thoroughly" is their motto. They always avoid discouraging the men, and try in every way to create a "desire and love" for firing.

In the Continental armies, recruited by conscription, the whole of the recruits come in a single batch each year, and consequently the captains of companies can easily train the whole of their men from beginning to end without any difficulty. But in the English service, when the recruits come in in driblets by voluntary enlistment, this is almost impracticable, at all events as regards obtaining the best results. The

taking a mass of men, because the Army is a great mass of average men. I believe that out of every 1,000 soldiers you examine in any army, you will find that 10 per cent. cannot even see at 1,000 yards, much less hit an object at that distance. I am really not exaggerating; they could not, I believe, see a man on horseback 1,000 yards off. Therefore to talk of making every man a good shot in our army is practically impossible."

undoubtedly best solution for our service is the employment of paid battalion Musketry Instructors, who train the recruits and then hand them over as trained to the captains of companies.

2. War Practice.

In beginning the war practices, the men should have fully impressed on them the fact that what they have already done in their target practices is simply to teach their men how to shoot, to keep their skill in shooting, and if possible to improve it, and that as it depended on the ranges being very accurately known, it could not be applied in war, because the enemy would not signal back the results of each shot. For this reason the words "war practice" are particularly chosen, though to train the men properly it should be further subdivided into *range practices*, over known ranges, and *field practices*, over unknown ranges, only trained soldiers carrying out the latter, 100 rounds at least being expended for each kind of practice.

In these war practices there should be but little individual firing; volley* and mass-firing, carefully controlled, and only executed by word of command, being chiefly used, in order to impress on the men the necessity of mutual, and not independent, action. In war, independent firing will come of its own accord, and need not be ordered (see p. 345), and so men need not be regularly trained to its use.

Still, however, men should be trained to execute a rapid accurate fire, for trained men can fire 10 rounds a minute, while untrained men can only fire 5 in the same time. All Continental nations instruct their troops in this.

The only individual instruction that should be given in these practices is, to teach the soldier how to hit, how to utilize ground, and how to make the best use of obstacles for cover, and how to take advantage of the time during which an objective may be visible.

Teaching men to fire on a moving or disappearing object is a most valuable instruction, and one to which great attention is paid abroad. Our own experiences in the field of late years have painfully demonstrated to us its necessity. The means of executing fire on moving objects are very simple and cheap;

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* In firing volleys, it is most essential to make all the men to fire together on the order "Fire!" or else, when the men are excited under an enemy's fire, if some men fire before or after the others, the firing may degenerate into an uncontrolled, independent fire.

the method laid down in the French Musketry Regulations seems all that can be desired.

The range practices should be executed by *squads* of men (see p. 408), recruits being in drill order, and trained soldiers always in marching order. The field practices should also be carried out in marching order.

These war practices should include judging distance drills and practices (the ranges being judged to within a tenth of the true range),* *firing at moving and disappearing targets*, and skirmishing. The skirmishing should be most rigidly carried out, in conformity with the principles laid down in Chapters XIV. and XV., so as not only to fully instruct and train the men to fire discipline and control, but to instruct the officers and leaders in directing the fire.

To ensure the necessary intelligence on the part of the men to carry this out, lectures on the object of fire discipline and control should be given them, which should also illustrate the necessity for a collective fire at all ranges over 400 yards.† To fully impress the men with this, they should be practically shown *by companies at war strength* (so as to get a sufficient number of rifles for concentration) the difference in the results to be obtained by independent and concentrated fire at guessed ranges.

Many circumstances, however, occur in action which take from the officers the power of controlling the fire. It will then be the duty of the non-commissioned officers, and in default of them any selected men, to carry this out. But under a very efficacious fire of the enemy, in the fight at close ranges, this method of action will cease to have any value, and success will then depend on individual initiative alone.

Hence arises the necessity of teaching and instructing the individual man so that he may be able to act according to his own instinct, and know, without being told at the time, how to utilise, in all cases, the properties of his rifle. *But this instruction is only necessary for the short ranges under* 400 *yards.*

The latest German regulations on infantry fire tactics say:— "The men ought to be instructed in such a manner that, in case the word of command cannot be understood, or the officers

* If officers, non-commissioned officers, and men under fire are expected to guess the range to within one-eighth of it, they should be trained to find it to within one-tenth in peace time. The distances judged should be those stated on p. 128.

† Experiments are really required to show this thoroughly, in which case a series of screens should be used when practicable.

and non-commissioned officers have been wounded, they will still be able to make a rational use of their rifle in accordance with the spirit of the instructions." This is the only case when the men are freed from the control of their officers. In Germany, individual fire is not freed from the control of the "zug" leaders, except in the case of marksmen, who are allowed to take the initiative if an opportunity occurs to kill an enemy's officers, or an orderly carrying a message, or a man supplying a firing line with ammunition. But as a rule, German soldiers are forbidden to fire a single shot without the permission of their officers.

Field firing proper, on varied and hilly ground, is of the greatest value of all, as it accustoms men more to the reality of war than anything else. It also affords instruction in inclined fire.

"The considerable influence that the form of the ground exercises on the effects of fire, imposes on all armies the duty of exercising its infantry on all kinds of ground, and not, as is generally done on flat ground alone. It is very necessary, also, to accustom the soldier to aim and fire quickly, in all positions and in all directions, with his arms free or supported, and from behind an epaulment, a wall, a tree, &c. In exercises on varied ground, it is not only necessary to teach the firer how to utilize the accidents of the ground to cover himself, but also, what is more important, to make a judicious employment of his weapon. Targets representing an enemy's soldiers, grouped and posted as in war, should be fired at if possible."—(General Brialmont).

These field exercises should invariably be carried out in accordance with a tactical object, and against a supposed enemy in position. The men should only have a very few rounds to start with, and then be supplied during the action, in order to accustom them to think of this important question, and to make them feel the value of not wasting their ammunition. Varied ground gives also the best practice in judging distances. Such exercises are all the more indispensable, as the eye and custom alone can regulate the fire in practice, and teach the men fire discipline, and the officers and non-commissioned officers how to control and direct the fire. *Knowledge and application (including judgment) are two very different things. The first is easy to attain, the second hard. The first depends on study, the second on constant practice.*

As field firing with ball cartridges can only be carried out in very few places in England, *two or three camps of exercise* might well be formed at suitable places within the United

Kingdom and at which every battalion should be sent once in three years for a course of field firing and field exercises generally. This practice has been in vogue in the English artillery for some years past, with the best of results. Such camps of exercise would be most valuable moreover in training our troops to field service, so that they will not enter the field not knowing what they have to do, as is so often the case at present.

The targets in the war practices should invariably resemble men. Aim should *always* be taken at the foot of the object fired at, and any hit (even by a ricochet) should count.

The standing and kneeling positions should only be used for the shorter distances, for the reasons given on p. 400; and the lying-down position for the medium and long ones. It should be carefully explained to the men, that when breathless and fatigued—as they would be at the short ranges—they fire better in the more upright positions, but to enable them to use these positions, the enemy must have been demoralised beforehand, or else the attack, in any case, would not succeed. The upright position also allows of a more rapid advance being made to the final assault.

As the field practices are intended to train the officers and non-commissioned officers in the direction and control of fire respectively, as well as to train the men to fire discipline, it is very important that the officers themselves, although they would never fire in action, should also have been trained like the men, so that they may know and realize exactly what elements and difficulties they have to deal with. Further, to give officers and non-commissioned officers the most perfect training possible, *all the units engaged in war practices should invariably be at war strength.* Nothing is more difficult, or conduces more to confusion in battle, than suddenly being called on to command a greater number of men than one has been accustomed to. Another important point is that *no attack formation should be practised without men, officers, and group-leaders, being fallen out to represent casualties*, for otherwise an unreal state of things occurs when the shooting line is reinforced.

The working by groups should be rigidly enforced in all war practices, and in practising the attack formation. "Field firing by groups is intended to habituate the men to fire discipline: that is to say, to commence and cease fire, to increase or diminish the rapidity of it, &c., at the wish of their leader; to fire with the sight ordered, on the object which is told them,

and not on the enemy in their direct front; to fire only the number of cartridges ordered; and lastly, to take account of the effect of their shots and of the consumption of their ammunition. This field firing, besides instructing the men, is intended to instruct the officers with regard to the direction of the fire. The officers learn by these exercises to choose the most favorable moment for opening fire, as well as the objective on which they ought to concentrate the fire; to estimate the distances; to observe the strike of the bullets; to regulate the fire by trial volleys. They accustom themselves also to the use of combined sights, the number of which they make to vary with the distance of the enemy, the slope of the ground near the object to be struck, and the depth also of the object. They have, further, to choose between the different kinds of fire; to consider the expenditure of ammunition to gain a given result, and to regulate the consumption of the ammunition, according to the available supplies and the phase of the fight."

General Brialmont writes:—"The success of modern fighting requires that troops should possess in the highest degree what is known as *battle discipline*, or *fire discipline*, that is to say, obedience in the middle of the emotions of the fight. This quality is only to be found in trained and disciplined soldiers, commanded by leaders who inspire them with entire confidence." To inspire confidence, the leaders must be capable of carrying out their duties of direction and control, and their capacity of doing this depends far more on actual practice than on mere study alone.

With regard to firing, the latest German musketry regulations lay great stress on aiming quickly,* in all the positions of standing, kneeling, and lying down; because in war the objects fired at are essentially mobile, advancing or retiring, appearing and disappearing, and so it is especially necessary to rapidly take up the line of sight in order to hit the enemy.

Field firing can be best carried out in the winter time, except in the proposed camps of exercise, when the summer time would be made use of. In the winter the country is open in every way, and offers opportunities for the most varied manœuvres, which further, cannot hurt any

* This cannot be done with the fine sighting of the Martini-Henry rifle. In any future rifle we have, the back-sight should be as near the eye as possible, and be graduated for a full fore-sight, by which means alone, quick sighting can be obtained.

cultivated land, as there are no crops in the ground then to be spoilt. In a great many places land could be temporarily obtained for field firing in winter time. A strip of country 2½ miles long by half a mile wide, is ample for a battalion, and a few patrols posted round would warn people off while the exercise was going on. This field firing, when properly carried out, is worth all the rest of the musketry instruction put together.

"Although new arms and new tactical forms are no doubt necessary for modern war, there is something more than these required to make our troops efficient. I mean 'tactical training'—the thorough training of our soldiers in what they have to do in war. . . . . Mere barrack-square drill will not suffice: all ranks must practice in peace what they have to do in war; and, until this is done thoroughly, no army can be called efficient."—(Capt. James). We are, as yet, far from this standard in the British army.

In war, volleys by groups would be kept up as long as possible, but in peace practice volleys should be used for ranges over 400 yards, and mass-firing *only* for ranges under these.

Any comparisons made between the different regiments in the service should be made by means of the results obtained by *at least two*, and if possible more, war practices. Twice or more times a year the same conditions of firing should be sent to every battalion on the same date, to be carried out as soon as possible without previous practice. Such comparisons of data, made by a considerable number of men, are not so much affected by the different conditions of ranges, climates, &c., as those of individual fire are, and they can therefore form a more or less reliable standard of the way in which the war training of a battalion and its officers has been carried out.

Although the men should be taught and practised to fire volleys by groups, yet no comparisons should be made of the results of such firing, because with such small bodies of men a sufficient number of bullets cannot be fired, as a rule, without allowing the men far more ammunition than is usually available, in order to obtain a true criterion of the efficacy of the fire. Major General Gordon said in 1883 on the discussion on Col. Fosberry's V.C. lecture on *Magazine Rifles and Repeaters*, given at the Royal United Service Institution "With regard to field firing, I have seen much of it in India, and from what has been said this afternoon, I don't think that the main object of its introduction is generally realised. Practice by squads of 10 or 12 men on a range or on known ground in no way meets the desired purpose. Its intention is to habituate the

men to firing in the greatest available masses, as on service, and to enable the officers and men to see the effect of such fire upon figures and screens which are entrenched and only placed on such ground as the enemy would occupy. Many advantages have followed this method of carrying out field firing, amongst them, the searching consequence of long range fire on screens, placed often out of sight of the firers, in covered positions such as would be occupied by the supports and reserves of an enemy." The lowest units between which any comparisons of collective fire should be made should be companies at war strength, and for this purpose the men should fire at least 5 rounds per man at each range.

Then again, such comparisons of war practices should only be made between tactical units of about the same size, for as General Hardinge has pointed out, experiments show that the quality of infantry fire is in inverse ratio of the quantity of men firing, which means that in field firing twice one does not make two, and that as the number of men firing is increased from companies to battalions, brigades, &c., the proportion of hits to rounds fired falls in a very rapidly decreasing manner. It is evident that a few skirmishers can shoot better than a greater number of them. because the smaller the number the freer will be their choice of ground, both for cover and aim, thereby obtaining the minimum of exposure with the maximum of effect. Again it is evident that a long line of moving skirmishers can neither advance quickly nor fire well. It cannot fire well, because a small unit like a brigade expands a fire line of about 800 paces, in which individual divergence is strictly prohibited, and also to maintain the true direction and intervals, even for a short distance, is high tension drill, and consequently bad ground makes it impossible, while the best ground makes it slow. Such a formation cannot advance quicker than 2 miles an hour across the zone of greatest danger, and also such a line cannot fire well, because small inequalities of ground, when a man lies down, become mountains hiding the object beyond, and thus blind an incredibly large proportion of the rifles of the already hampered advance. For all these reasons comparisons between the results of field firing should be confined to those of units of about equal strength.

The annual inspections by the general officers commanding districts and garrisons should be by means of the war practices only.

In these war practices very great stress should be placed

on the instruction of officers and non-commissioned officers in fire direction and control.

As weather does not affect the results of concentrated firing nearly so much as it does individual firing, the war practices should go on all the year round, except during the times required for individual firing and for the summer drills.

Résumé.

The above system of musketry instruction, based on a complete separation between target and war practices, seems, from the data given in Parts I. and II. to be as rational and practical a system as it is possible to give to troops, and one very suited to field service. Throughout it the aim has been to make the principles of musketry instruction to go hand-in-hand with the tactical requirements of the battle field—which should be the aim of all military instruction, organisation, institutions—and to give the greatest weight to the war practices.

A soldier during his first year should only be put through the recruit's course, and through the trained soldier's course in his subsequent years; a recruit has so much to learn in his first year that he should not be pushed too much.

There should be separate musketry regulations for cavalry and infantry, and each should be divided into four distinct parts, viz., the training of the recruit and of the trained soldier, and target and war practices. These regulations ought to give many illustrations of the rifle, its sights and the methods of adjusting them, methods of aiming, diagrams showing the apparent sizes of the targets at different ranges when the book is held at arms length, apparent size of men in different positions at different ranges, &c., &c. Nothing impresses the mind so much as diagrams, a good illustration is worth pages of explanation.

For such a system of musketry training we see that it is most essential that the company officers should train their own men after they have been handed over to them as trained recruits by the musketry instructor, so as to accustom these recruits to fire discipline and to the control of their own officers and non-commissioned officers, and also to accustom the officers to their higher duties of direction, and the non-commissioned officers to the control of the firing groups.

With regard to the extent and character of the training in musketry required for both men and officers, we cannot do better than quote the following extracts from M. E. Simond's *De la tactique des feux et des armes à répétition* (1884). "It is necessary not to demand too much from soldiers, and to avoid

filling their heads with fine theories, three-fourths of which they do not understand, and the other fourth is forgotten within two months after they leave the colours. It is necessary to train the soldier practically, and to habituate him simply to adjust his sights and to aim quickly, after having loaded . . .

"The men will be trained when they can fire quickly while aiming fairly well, and when they will instantly obey the commands and signals to cease or open fire.

"The duty of the officers is more delicate. To know how to direct the fire with discernment is no easy matter. How can they learn to do it? Not by theories and lectures, but only by practice. They should have frequent exercises in field firing *on varied*, and, if possible, *on unknown* ground. The results would speak far more plainly than any doctrines. Let us (the French) use fewer cartridges in training men to attain an accuracy of individual fire which has not in war the great importance usually attached to it, and let us make use of them rather in teaching the leaders the employment of fire. It is by far the most important question, and one which is neglected the most.

"It would be easy to show that a great accuracy of individual fire has no practical value on the battle field, for one simply seeks to cover with bullets the zone of ground on which the enemy moves. A rigorous accuracy of individual fire would only be important if the rules for using the rifle could be applied, which is never the case in war, where distances are unknown or badly appreciated, on account of which the fire of bad shots may be more efficacious than that of good marksmen. Besides, in order that these latter, who form a small minority, may continue to fire well, it is necessary that they should have the same presence of mind and calmness as they have on the practice range, which is impossible. Thus, a great precision of individual fire has but little value in battle. It is sufficient if the mass of the men can rapidly adjust their rifles in a given direction.

"The French Musketry Regulations recognize the small importance of great accuracy for individual fire, by authorizing, in certain cases, the simultaneous employment of several sights, which is the negation of an accurate fire. They recognize it still further by saying, that 'in using the elevation for 300 mètres, *which is the true elevation for the close fight*, all the ground up to 350 mètres is swept by direct hits, and, if the soil is favourable for ricochets, a considerable distance beyond this is also rendered dangerous. *The elevation for* 450

mètres can be used up to 450 *mètres* against standing men; it is the best elevation for use against cavalry at the short ranges.'

"Thus, at the long ranges, the errors of appreciation, the atmospheric conditions, and the simultaneous use of several sights, make the accuracy of individual fire of no practical value, and at the short ranges, where it would have some value, the exact elevation would never be employed!* What is the use, therefore, of losing much time and money to teach soldiers to fire with rigorous accuracy, if they can never make use of this accuracy in battle? It is very useless, in time of peace, to teach men a mass of unpracticable rules which would be neglected on the battle field. . . .

"It is useless for the soldier to learn anything else than to fire quickly, with the elevation ordered. The rest belongs to the leaders, especially the officers. It is by field firing that these latter learn how to skilfully employ the fire, and how to profit by the occasions which always present themselves at given moments during an advance against an enemy."

No one can dispute the truth of these words, and they seem to indicate that fewer rounds should be devoted to individual firing than even those suggested on p. 400, and that the surplus should be added to those allotted to the war practices.

The Duties and Objects of a School of Musketry.

The School of Musketry at Hythe, as at present constituted, is not on a footing compatible with its supposed high duties of advancing the war training of the army in shooting. All that is taught there is (1) to make the officers and non-commissioned officers sent there learn the firing exercises, the position drill, and certain very simple lectures on the theory of musketry, by heart, and the musketry regulations very nearly so; (2) to teach such officers as wish to learn certain rather higher branches of the theory of musketry; and (3) some elementary principles of fire tactics.

The first part should be learnt by the officers, &c., *before* they are allowed to go to Hythe, and the second and third parts could easily be taught at the Royal Military College at Sandhurst. There is no reason why this latter course should not be taken, as the cadets at the Royal Military Academy at Woolwich (young men just from school) are instructed there in such questions, under the head of "Gunnery," to a far higher degree than is even laid down in the official Text Book for Musketry used at Hythe.

* Exactly the same remark applies to the musketry fire tactics laid down in the new drill-book for infantry, and in our latest musketry regulations.

The musketry regulations state that the School of Musketry is established (1) for the special musketry training of officers and sergeants, in order that they may qualify themselves to train their troops and companies; and also (2) that a uniform system of instruction may prevail throughout the army.

This latter object is quite unnecessary, as it can be fully ensured by the regulations if they are adhered to, as they should be, and by appointing officers as *Inspectors of Musketry* in each military district. If regulations cannot ensure this, then we ought to have special schools for drill, and various other subjects. The appointment of Inspectors of Musketry is a step in the right direction, and would allow the School of Musketry to devote itself to higher things than it does at present.

The former object ought to be what the School of Musketry should confine itself to, but not in the way that it does now. It ought to be a great experimental school, at which officers of all ranks should be assembled, to see such experiments of collective fire, inclined fire, indirect fire, &c., as cannot be carried out in every place, and which require experienced officers to conduct them where they can be carried out. Half-yearly reports on any such firing carried out should be sent to all battalions by the School of Musketry. It should be the duty of the officers who have attended the School to impart to their battalions on their return, what they have seen and learnt there. The duty of a School of Musketry should be to keep up the instruction of the army in shooting to modern tactical requirements, and to the ever-improving power of the rifle; it should originate improvements in arms and tactical methods of procedure, and not be content to follow the footsteps of others,—those who follow are always behind.

As an example, the following are the objects for which the Prussian School of Musketry at Spandau was instituted, as stated in the decree ordering its establishment:—(1) to improve the arms and ammunition in the service; (2) to make experiments with the arms of foreign nations, and to keep the national army informed of the real value of the armament of its possible adversaries; and (3) to form good musketry instructors, and to spread throughout the army a profound knowledge on fire-arms and their properties. These duties are carried out by a permanent staff of officers and non-commissioned officers, assisted by an "experimental detachment" and an "instructional detachment." The course of instruction lasts 5 months.

The Belgian School of Musketry at Beverloo, has

for its object: (1) to introduce a uniform system into the methods of fighting, to spread throughout the army a profound knowledge on the fire-arms, the ammunition, and the methods of firing in use, and on tactics, the use of ground in war, and fortification on the battlefield; (2) to form good instructors; and (3) to study the fire-arms, ammunition, and methods of firing, and the regulations on the tactics and field service of infantry in foreign armies, to make experiments on varied ground, and to deduce from them the modifications necessary to be made in the fire-arms, ammunition, methods of firing, and regulations of the army.

The course of instruction lasts 3 months, and is divided into 3 parts.—

1. *A tactical course*, bearing on the most recent changes introduced into the tactics of marching, fighting, and halting, (as actually applied to ground) of foreign armies. These changes are compared with the home regulations, and even experiments are made in the country to test their value.

2. *A field fortification course*, for the use of infantry, in which the progress realized in foreign armies is examined.

3. *A musketry course*, in which the methods of firing at different ranges are shewn, and how to maintain fire discipline: a comparative study of foreign rifles, ammunition, and methods of firing is also made.

The Russian School of Musketry at St. Petersburg has for its object (1) to prepare company commanders, by means of theoretical and practical instruction, for the execution of the duties which fall on them as chiefs of a fundamental unit; (2) to spread throughout the army rational ideas on the employment of fire in action; (3) to assure uniformity in the instruction in firing; (4) to study, under all aspects, the portable firearms adopted for the Russian Army; (5) to study any improvements proposed for the portable firearms, cartridges, and everything affecting the armament and fire; (6) to make experiments; and (7) to collect information concerning the arms in use in foreign armies. The commandant of the school is an officer of high rank, and he is assisted by a permanent effective, composed of a personal staff, a staff of professors, and a firing company, and by a variable effective, composed of officers and men of different corps, detached during the summer to raise the firing company to the strength of a battalion.

The Austrian School of Musketry is formed on a similar basis, and it is only when the English School of Musketry takes upon

itself these high duties, and leaves those alone which can be taught elsewhere, that its real influence will be felt in the army. At present it teaches nothing but what can be easily learnt elsewhere.*

Instruction Firing.

On p. 466 we made a reference to "Instruction firing" as forming part of the proposed recruit's course. This firing does not exist in our service, but a high value is placed on it abroad. Its objects are (*A*) to practically demonstrate to recruits the ballistic qualities of the rifle that they have been told of in lectures, which includes an illustration of the effect of errors in sighting, and of the grouping of the rifle at different ranges, and (*B*) to show the effect of the fire of masses. In Germany the most important exercises of this kind, and the way they are carried out, are as follows:—

(*A*). The practical demonstration of the ballistic qualities of the rifle is divided into five exercises.

(a) The determination of the point of mean impact in the fire of different rifles. A good marksman, with the aid of a support-fires 5 rounds at 100 mètres with three rifles, one of which is fairly correct, and the others more or less inaccurate, while using the same sight and always aiming at the same point. The men are then shewn the fact that each rifle produces a different shot group, that the point to be aimed at varies with different weapons, and that therefore every man must carefully consider the peculiarities of his rifle in order to know what line of sight to use in different circumstances.

(*b*). *Demonstration of the size of the Shot Groups at different ranges.*—A good marksman, with the aid of a support, fires 25 rounds at each of the distances—200, 300, 400 and 600 yards, against one or two targets with a large surface. The recruits are then shown the relative size of each group, and then, consequently, the limits within which the accuracy of the rifle allows one to hope for some result from every shot when the range is known.

(*c*). *Representation of the trajectories of the fixed, flap, and leaf sights† by the heights of the different ordinates.*—A good marksman, with the aid of a support, fires five shots at each of the following ranges, with each of the sights named:—

* German officers speak and write of the "good fortune" of being able to go to their School of Musketry at Spandau. Can the same be said with regard to English officers and their School of Musketry?

† See footnote on p. 75.

1. With the fixed sight, at 50, 100, 150, 200, 250 and 300 yards.

2. With the flap sight, at 50, 100, 150, 200, 250, 300, 350 and 400 yards.

3. With the leaf sight, at 100, 150, 200, 250, 300, 350, 400 and 450 yards.

Aim in all cases being at the foot of the target.

The recruits are then shown the position of each shot group, and a man is made to stand and kneel by the side of the target, on the same level as the point aimed at, so as to show the chances of hitting him with each sight at shorter ranges than for which it is suited. The effect of taking aim below small objects at ranges under that for the fixed sight is also shown.

(*d*). *Representation of the influence of the sword-bayonet being fixed to the muzzle while firing.*—A good marksman fires seven rounds at 200 yards, first with the sword-bayonet fixed, and then without it, while always aiming at the same point. A comparison between the two situations of the two groups shows the recruits the lateral and vertical errors due to the influence of the sword-bayonet.

(*e*). *Firing from behind a trench against small movable objects, which are sheltered behind a parapet, and protected besides by sand-bags filled with earth or other artificial cover.*—This exercise is executed by several skilled firers, who, before their comrades, fire, at 200 mètres, against some dummies placed behind a rampart made of filled sand-bags, in which some openings are left to represent loop-holes, and through which the projectiles have to pass to strike the dummy enemy. The men who are not firing observe the shots, and indicate the necessary corrections. They are then impressed with the importance of a good observation in war, in order to rapidly obtain a judicious correction of the fire if it is ill-directed.

(*B*). The demonstration of the efficacy of the fire of masses is divided into three exercises.

(*a*). *The representation of the efficacy of the fire on a given portion of beaten ground, with the use of one or two elevations.*—This exercise is carried out by a group of 10 to 25 firers, who, while lying down and aiming at the foot of the targets, fire 100 rounds independently, at six targets 20 mètres apart, from 640 to 740 mètres, with the 700 mètres elevation; then with the combined sights of 650 and 750 mètres these same men fire 100 rounds at six targets 40 mètres apart, from 600 to 800 mètres. From the hits made on the targets, the points of fall of the bullets on the ground, and, consequently, the density of the fire at a given point on the beaten ground, are easily deduced.

(*b*). *Day firing, under the conditions of siege warfare.*—In this exercise groups of men, placed in shelter trenches, fire from 400 to 700 mètres against objects 14 in. high (or head targets), placed on some mounds of earth, to represent the height that the heads of an enemy's infantry would appear above a parapet.

(*c*). *Night firing, on supports or rests.*—In this exercise groups of men fire—at distances of 200 and 400 mètres—against targets representing sections of 60 men in closed ranks, or against targets of different widths, representing groups of men. During the day the men are shown how to best place the supports on which their rifles are to rest, so as to keep them in a fixed direction; then the men are made to fire, during the day, from these supports, in order to allow them to take note of the angular error which each rifle may make during the fire, and to thus teach them to avoid, as much as possible, this source of error in night firing. After this, the proper night firing is proceeded with, the supports being only placed on the ground at nightfall, and the fire being only commenced when it is perfectly dark.

Such are the demonstrations, at once both practical and elementary, that the German soldier receives during the "instruction firing."

The great value of instruction firing is to vividly impress on the men's minds the relative values of the different kinds of fire at different ranges. It is only when this has been done that we can hope to get them to work in groups under fire and not independently.

Another kind of instruction shooting, much employed in Austria, France and Germany, is effected by means of *chamber rifles* (see p. 466). This kind of firing has been lately introduced into England by Mr. Morris, by means of a tube, which fits into the bore of the Martini-Henry rifle, through which is discharged a miniature bullet at miniature targets, at ranges up to 300 yards, while it can also be used in a long room.

This innovation promises, in an indirect way, to give a very powerful means of developing the individual skill of both the recruit and trained soldier in shooting.

In the first place, as there is no recoil to unsteady a recruit, it is invaluable to teach him the effect of errors in shooting, how to aim, and how to use the sights, and to see if he "pulls off" in releasing the trigger. It is well adapted also to illustrate the rise of a bullet in its trajectory and other points in the theory of musketry. By it men can be perfected in aiming, in pressing the trigger at the right moment, in

keeping the sights upright, and in using the sights for the longer ranges, and thus bringing the rifle, hand, and eye to work together in unison.

The following extracts are taken from the report of the Committee of the National Rifle Association on the Morris Tube and Sheds:—*

"The ordinary aiming drill and snapping of triggers is virtually useless for young soldiers, for there is nothing to show them their errors; but with the 'Morris Tube' and its diminutive cartridge it is otherwise. We therefore consider that for the ordinary aiming and snapping drill, actual shooting with the 'Morris Tube' and cartridge might be substituted with the best possible results, especially for recruits. We are further of opinion that with a preliminary course of drill with the 'Morris Tube' and cartridge, the ordinary course of blank cartridge firing might be dispensed with, as young soldiers would thereby derive so much more confidence in the use of their weapons that they might at once pass from the drill with the 'Morris Tube' and cartridge to actual practice at the targets. There would thus be a considerable saving of money in the discontinuance of blank firing in the course of musketry drill, which would go very far to supply the tubes and ammunition that would be required for the training of recruits."

Even instruction can be given, by means of these tubes, in firing at miniature disappearing and moving targets representing men, horses, &c., at different ranges.

The best proof of the use of these tubes is that those who have used them have made the best target shooting in practice. Thus they have "a real and practical value which cannot be easily over-rated, both as an educational agent in rifle shooting for recruits and young soldiers, and as a valuable means of rifle practice for the trained soldier, especially in cases where access to open rifle ranges is both difficult and costly. We also think they would be a great attraction to soldiers, if, under due supervision, the latter could freely use them for private matches, which would tend more than anything . . . to develop and foster an interest in the most necessary branch of a soldier's education, viz.: rifle shooting."

* The shed is only an arrangement to intercept all ill-aimed or accidentally discharged shots, and so render them perfectly harmless.

CHAPTER XVIII.

THE USE OF ENTRENCHING TOOLS IN THE FIELD.

The fire of artillery, and the rifle fire from masses of infantry, are so terrible now-a-days, that attacking infantry cannot hope to advance against them until their power has been reduced by the demoralisation of the troops using them, and neither can the defending infantry expect to live under them, unless they are protected by some means from their effects. In fact, nothing unprotected can live under the effective fire of masses of infantry or of artillery, and hence the only solution is to seek for some means of protection against the deadliness of an enemy's fire, until it can be sufficiently subdued to advance against him. In many places, natural cover can be made use of, such as folds of ground, trees, hedges, walls, &c., but it may not be placed exactly where required. Defending troops generally take up an elevated position, and in doing so, it is highly important that the foot of the slope should be seen, to prevent the enemy collecting there in safety to re-form for a further offensive movement. Where this cannot be done there is great danger, as was shewn in the capture of the Rotherberg spur at Spicheren, and of Majuba Hill in the Boer War. If the natural cover to be obtained is behind the crest of the position, it is of no use for the protection of the troops required to fire over the slope in front. Hence other means must be sought to obtain the required protection, and the earth itself is the only possible other resource, but to make use of it spades must be carried somehow. We read, in almost every page of the war history of the past, of the use of earth as a means of increasing the power of the defence,* but, except for data for use in our savage wars, it is useless to study too closely what was done in this respect in wars before the year 1866, that is, before the introduction of the breech-loader.

All the earthworks employed before that date were not for mere cover alone, which was then a secondary consideration on account of the want of accuracy and of range of the weapons in use, but much more for a material obstacle to the

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* The Romans are said to have conquered the world with the spade.

attack. But by far the greatest obstacle the attack has now-a-days to overcome is the fire of the defence over a clear field of fire of at least 400 yards, and hence if the defenders have this open space in front of them, capable of being swept by their fire, they have no need of using heavy earthworks *as obstacles*, which require much time and labour to construct, but only such cover as will give them *shelter* against the enemy's fire The only exception to this will be in those cases where the defenders are very greatly out-matched in numbers, as in our savage wars, when the enemy must be actually stopped by obstacles to prevent his closing. In our own late wars, we can find examples of what has been said above. In the Zulu War at Isandlana, our troops had no protection of any kind and they were overwhelmed. The same night at Rorke's Drift a small gallant body of Englishmen bravely held their own, against overwhelming numbers, behind an improvised *obstacle*, built up of sacks of flour, biscuit boxes, &c. At Kambula also our troops were only saved from annihilation by their *obstacle* defences. In the Boer War at Majuba Hill, the position our troops took up prevented their seeing and defending the slopes up which the Boers advanced, but they could not have been placed over the crest, (as they should have been), because they had no means of throwing up cover, and so would have been shot down by the wonderful shooting of the Boers. At Ingogo we were in the open, with no natural shelter, and suffered greatly for want of means to obtain artificial cover from the ground. It should be always remembered that if cover cannot be obtained that can give complete protection from fire, the next best thing is cover from sight, because anything which can prevent an enemy taking a definite aim must reduce the efficacy of his fire, so that, at all events at the commencement of a fight, any kind of cover should be sought for and made use of.

The American Civil War teems with instances of the use of both obstacle and shelter entrenchments, and it was by their use that the exhausted Southern States were enabled to so long maintain their struggle with the overwhelming forces of the Northern States. Both obstacle and shelter works were freely used in this war, the former especially by the weaker side, and in woody country where the enemy could advance to short ranges unseen. In the Prusso-Austrian War of 1866, the Austrians, when they found themselves out-matched in armament, and forced to act on the defensive, should most certainly have made the greatest use of entrenchments; but

they neglected to do so, and suffered enormously in consequence. In the Carlist and Franco-German Wars shelter trenches were freely used, and the great battle of Gravelotte, in the latter war, might have ended differently, had not the French ammunition run out on their right. Skobeleff's opinion on this latter war was as follows:—"There can be no doubt in my mind that the French Campaign of 1870 would have ended with much better results for the French had they, during the second period of the campaign, and in view of the present armament of infantry, and the comparatively weak effects, as far as decisiveness goes, of long range artillery, confined themselves strictly to unexpected strategic attacks (especially along the lines of railways, for instance), combined with a purely tactical mode of defence, with the aid of field fortification." During this second period of the campaign it must be remembered that the French armies were composed of very badly-trained levies. The Russo-Turkish War, like the American Civil War, was notably a war of field works, and had the defenders of Plevna been properly backed up by their field armies, or had the Russians not fortified the Shipka Pass, the war might have ended very differently. "Everywhere in the fights at Plevna, at Lovtcha, and wherever the attack had to advance or hold its ground, the want of tools, was severely felt by the Russians. In the struggle to hold the redoubts on the 'Green Hills' taken by Skobeleff, the men, enfiladed as they were on both flanks, worked all night with sword-bayonets, canteen lids, and hands, and even threw the dead into the gaps to bar the Turks." Everyone has read Skobeleff's complaints of the want of tools before Plevna. No one could accuse him of want of dash or recklessness under fire, and yet, when his division was led south to assist in a very rapid advance on the Turkish capital, he provided his men with Turkish spades, which they cheerfully carried to Constantinople, slung across the back, having learned their value in battle. Col. Fraser, R.E., who followed the war, quotes the following extract from a Russian report:—"If the Government does not give its infantry a portable spade, the soldiers will buy them with their last pence."

While the Russian generals in 1877 thus strongly deplored the neglect that their Government had shewn in not providing a sufficient number of portable tools, the Austrian generals, who conducted the campaigns in Bosnia and Herzegovina congratulated their own Government in having taken the precaution of providing a spade to every two men.

Thus, Austrians, French, Germans and Russians have all felt the advantage of even the most hastily constructed defences in war, and although all these nations lay the very greatest stress on the necessity of taking the offensive in battle, yet they one and all, especially since the Russo-Turkish war, have adopted light entrenching tools as part of the infantry soldier's equipment, to be used as infantry weapons, little less effective in their way than rifles. As the tide of battle rolls backwards and forwards, the offensive and defensive attitudes of the contending sides change; the entrenching carried out by the side first acting on the defensive is, as a rule, fairly complete; that executed during any offensive movement is usually confined to rapidly placing captured positions in some kind of state for defence, so as to act as a tactical point of support for covering any possible subsequent retreat. As a rule in an attack, special troops (engineers and pioneers) would be sent forward for the purpose of securing the ground gained, but these troops may be wanted for other duties or elsewhere engaged, and so the attacking infantry themselves may have to do the work, as at Plevna. Hence the necessity of infantry, under all conditions, being provided with entrenching tools, is now fully established in every army, and the next questions are, what kind of tools are required? and how should they be carried? Taking this latter question first, wagons with entrenching tools are of little value, as infantry have to work over fields and fences, through woods and enclosures, and on ground over which wheeled vehicles cannot pass, and so the tools may not be forthcoming when wanted. To be of real value the entrenching tools must go with the rifle, and the principal ones, at all events, should be carried on the soldier.* This principle has been accepted in every Continental army. General Skobeleff's opinion, given in his report of the third battle of Plevna, has often been quoted, that the first thing a soldier throws away when in difficulties is his entrenching tool, and that therefore it would be better either to send the tools after the attacking force, or to have a special corps attached to each regiment (of three battalions), whose duty it is to place any captured position in a state of defence. But General Skobeleff in the march on Constantinople made the troops carry the tools themselves. Of course, when possible, such works would be carried out by special troops if they are available, but reliance should not be placed on such assistance.

* Napoleon I. said that the entrenching tool was one of the five things that a soldier should never part with. See footnote on p. 286.

Further, General Skobeleff pointed out that, from his experiences before Plevna, no earthwork defended by the modern rifle could be stormed unless dispositions, determined towards sunset, were matured by a night of active countermining. As infantry would have to do this work, this again is another reason why they should always carry entrenching tools with them, so that they may be forthcoming when and where required.

The nature of the tools to be carried must depend on the work to be done, or that can be done. An examination of past wars shows us that the principal work carried out in field entrenching consists of constructing shelter trenches, loopholing walls, cutting down trees, hedges, &c., and making abatis and wire entanglements. To construct shelter trenches, a spade and pickaxe are required; to loophole walls, a pickaxe, crowbar, or jumper; to cut down trees and make abatis, an axe in addition to a spade and pickaxe; to make wire entanglements, wire nippers and an axe. The Wallace entrenching tool (23 inches long* and 2 lbs. 4 ozs. in weight) has proved itself, after exhaustive trials in England, to be the best and simplest of portable tools, and as it combines a spade and pickaxe in a solid and simple manner, shelter trenches and loopholing can be easily carried out with it, and it is *par excellence* an infantry tool. Thus, if the mass of the infantry carry these spades, the remainder of the men can carry axes, which would provide ample tools for offensive purposes, while the battalion entrenching tool wagons could carry an extra supply of axes and crowbars, and as much wire (and some nippers) as possible for more permanent defensive purposes, when the wagons can be expected to come up to the troops. For still larger and heavier works the Engineer Park would supply the necessary tools, but it must not be forgotten that the siege works at Plevna were mostly thrown up by the portable spade carried by the Roumanian troops.

Artillery can, of course, easily carry on their guns and wagons, the necessary tools for constructing any epaulments, &c., that they may require.

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* The blade of the spade is 7 inches long, so that the length of the spade, plus the blade, is 30 inches. The ring holding the metal of the pickaxe (which forms the handle) to the shaft ($1\frac{1}{8}$ inches thick) is 18 inches from the end of the blade. The pickaxe is 8 inches long from point to point, and where the shaft joins the blade there is a swell to keep the knuckles from coming in contact with the ground. The above dimensions of the spade and its parts are to suit the measurements required for constructing shelter trenches.

As said before, infantry must be prepared to carry out any defensive works required, both in attack and defence; and hence infantry ought to be capable of designing and executing all kinds of works, except field redoubts, which are rarely required, from the time they take to construct, the amount of material they require to have collected, the extensive organisation of working parties necessitated, and the greater number of workmen their construction entails as compared to their subsequent garrison (16 to 1); breastworks with or without a ditch in front, and covered with obstacles if possible, are amply strong enough for most cases, and these infantry can easily design and construct. Where they can be spared, engineers would be employed in an attack to follow the infantry and secure, by defensive preparations, any success they may gain. Their other duties in war time are very numerous in connection with the construction, destruction, and repairing of bridges, roads, railways, telegraphs, superintending working parties in every kind of work, printing, surveying, photographing, &c., &c. It must not be forgotten, which, however, is most commonly done, that, except in action, the duties of engineers is essentially one of superintending infantry working parties; the smallness of their numbers, and their high training being a sufficient proof of this.

When a mere *shelter cover* is all that is aimed at, as would only be done if the time is short, or the field of fire ample, or if the troops are fairly strong in numbers, or it is not wished to tie them down too much, it must be remembered that after a certain point, its strength does not increase proportionately with the time; but with *obstacle cover*, which would be used if the field of fire was very small, if the available time was sufficient, or the defending troops relatively weak, it is otherwise. As far as shelter cover is concerned, a position will be strengthened, as far as it can be, in about two to three hours, if the tools and men are forthcoming.

With regard to the distribution of tools in the German service, in each company of 250 men there are 100 small spades, 10 small pickaxes, and five axes carried by the men; then, in addition to these, there is carried in a wagon, per battalion (of four companies), 111 large entrenching tools, including spades, pickaxes and axes. It is said that the Wallace spade is to be introduced into the German and French services. In considering what distribution we should adopt for our service, we must remember that, though a

battalion, 800 strong, would occupy a shelter trench about 400 yards long on the defensive, requiring say 400 tools, yet the supports and reserves have also to construct cover for themselves and perhaps a second line of defence, so that nearly every man, say 80 p. c. in each company,* should carry the Wallace spade, and the remainder should carry small axes for woodwork, making abatis, clearing ground, &c.

It may be useful here to point out the difference between English and German practice in the construction of shelter trenches. The Germans have three kinds of shelter trenches, for men firing lying down, kneeling and standing respectively. The shelter trench for men lying down corresponds to our shelter pit with a parapet one foot high ; that for kneeling is 16 inches deep and 40 inches wide, with a parapet 20 inches high ; that for standing is 20 inches deep, and wide enough to provide earth for a parapet 32 inches high. The Germans have no wide, shallow shelter trench like ours for the lying down position, they seek for cover, not in width of trench and thickness of parapet, as we do, but in depth of trench, and height of parapet, which is the true principle of gaining shelter.

The British soldier is well known to have an inherent dislike to digging, but so had the Russians at first (in 1877), for we see that the first thing they threw away was their entrenching tool, and yet after the first rude shock of war we see how eagerly they clung to them subsequently. We ought to train our infantry to use entrenching tools freely, and the best way to make them do so is to make them always carry them and be continually practised with them. The men would thus soon learn to feel that the entrenching tool is as much a weapon for their use as the rifle. The prejudice against the use of the spade is not reasonable. "The (British) infantry must rise to a higher conception of its functions and duties if it would not fall back behind that of all Europe. The recruit must, indeed, be first trained in the barrack square to discipline of limbs and mind ; but that once done, he must be developed into the best possible fighting animal. Drill is all very well as the alphabet of his work, but too much of it, unrelieved by higher training, kills that individuality which is above all things necessary to the fighting of to-day.

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* This proportion should depend on the nature of the country. It might vary between 70 and 90 per cent., according as the country is known to be more or less wooded or intersected with hedges.

This is the secret of the Boers' success (in 1881) as far as it went: but there is no reason why the English soldier should not, on an average, be a better fighting animal than the average Boer. He may probably never attain to quite such proficiency in shooting, but he may add many qualities which the Boers have not. The development of the individual, coupled with discipline, will do wonders, and one of the directions in which that development should move, is the use of the spade." It may be here remarked that the opinion of the great German writer, Von Boguslawski, on the Boer war is that our defeats were far more due to our tactical errors than to the superior shooting of the Boers, and an impartial study of the war will lead anyone to the same conclusion.

The value of entrenchments depends on the troops holding them (*vide* Plevna and Tel-el-Kebir). "In considering the whole question of positions, we must never forget that though positions may increase the resistance of troops, yet the troops themselves must be considered first. He who expects too much from the ground will be left in the lurch" (Von Waldstalten). Through neglect of this last principle we suffered severely at Majuba Hill.

Shelter cover is only required during the first stages of the fight until the enemy is demoralised, when the troops must leave it to take the offensive, and hence such cover must be easily crossed to enable such a movement to be made.

Some writers are opposed to earthworks where this offensive action has to be made, saying that they would tie the troops down, from their not liking to leave them. But, if troops are trained to look on such shelter cover as merely a temporary resting place or musketry position, then there will be no difficulty in getting them to leave it to conclude a victory. The French, Carlists, Russians, and Turks freely left their shelter trenches to attack with the bayonet.

But obstacle cover, such as heavy field works, do tie troops down. Hence they should only be used by the defensive when there is a great inferiority of numbers, and at such points where a subsequent offensive counter-attack cannot be made. These heavier works are consequently more suited to protect the flanks and rear of a position than the direct front.

Seeing the great importance of even slight earthworks to protect infantry against the fire of modern rifles and artillery, it is hard to understand the delay that there has been in

providing the British infantry with the Wallace entrenching tool. It is highly important that they should carry it whenever they parade in marching order, so as to make them feel it is a very essential part of their equipment. Further, in their annual course of training, they should be frequently practised in its use to make the men feel its importance and to destroy any prejudice against it. Even at drill they should be made to go through the motions of using it in places where they may not turn up the earth. Many writers have stated that "the earth is the true shield or breastplate of infantry," and this spirit should be imbued into the men.

A well-known German writer, Capt. C. Von Widdern, says:—"In the attack, as in the defence, it is desirable that the spade should be utilized as much as the rifle and bayonet. It is high time to accustom infantry to consider this tool, equally as the rifle, as an *arm* from which it can obtain profit, not only on the defensive, to resist the attacks of the enemy, but also on the offensive, especially in order to promptly put a newly-captured position in a state of defence, and to thus ward off any offensive returns." One of the most characteristic features of the annual German Autumn Manœuvres is the multiplication of field works. Hasty field works are freely used on the line of outposts, on the main line of defence, and on the line of retreat. "Even during an engagement the infantry throw up earth at every step, and place the edges of villages and woods into a state of defence, and this, too, as much on the offensive to secure the positions gained, as in the retreat to hold on to the ground."

To use the tool in offensive movements the men should be trained to use it lying down. To enable it to be got at at any moment the Wallace entrenching tool is attached to the bayonet frog, in which position it has not been found to inconvenience the men in their movements in any way.

All experience points to a very great use of entrenchments in the next European war, (in which we may be engaged), in order to minimise the effect of modern weapons, and as such works favour the defence more than the attack, it is very essential that our small army should make a special study of them, and that it should be given the opportunity, not only to make them once in a way, but to practice them constantly.

One of the best tacticians in the German army, General Baron Von Wechmar, writes:—"It often happens that isolated fractions of an advancing force will be obliged to act

temporarily on the defensive. For instance, an advance guard may meet an enemy superior in numbers, and may fear being attacked before it can be supported by the main body. In such a case, this advance guard, instead of engaging in a doubtful offensive combat, would do everything to fortify as much as possible a rapidly-chosen position, by means of shelter trenches and epaulments. In a future war, when we (the Germans) will no longer have a numerical superiority, and when our adversaries will be better prepared to resist our offensive blows, *which will be as rigorous as formerly*, the employment of the auxiliary means, offered by fortification, will often be necessary. Are we sufficiently exercised in these improvised works of fortification on the battle field? We do not think so. *Practice is absolutely necessary in order to know how to rapidly choose the ground to be strengthened, and to calculate the number of men and tools, as well as the time required for the execution of the works.*"

One of the most ready obstacles that can be made in the field is a bough abatis, while the best obstacle to an enemy is a clear field of fire. Hence it frequently happens that brushwood has to be cut away, in front of a position, and boughs obtained. In the absence of axes, the British infantry, as at present equipped with a triangular shaped bayonet, could not do this. If our troops had sword-bayonets, such as the troops of France, Germany, and Austria possess, then a good deal might be done in this way, even without axes. These sword-bayonets are quite capable of doing the lighter work of cutting down boughs and brushwood. In the accounts of the late Soudan campaigns we frequently read of the use made by the Royal Engineers of their sword bayonets in cutting down bushes and forming "zerebas." The sword-bayonet is just as good for killing purposes as the present bayonet in use by us, which is perfectly unfit for any other purpose than stabbing. Cutting brushwood, &c., with a sword-bayonet would not impair its stabbing qualities, because the momentum of a heavy rifle, impelled forward with the strength of a man's arms, would drive a sword-bayonet attached to it, however blunt its edge might be, through anything in reason.*

* Since the above was written it has been decided to introduce a light sword-bayonet into the English service.

CHAPTER XIX.

MAGAZINE RIFLES.

A magazine rifle is one which contains in itself, or attached to it, a supply of ammunition, independent of that in the soldiers' pouches, and which can be passed into, and ejected from, the rifle, without having to handle the cartridges in any way, thus causing a greater rapidity of fire while the supply of ammunition on the rifle holds out. *Hence, other things being equal, that magazine rifle is the best which contains the greatest number of cartridges.*

The question of the use of magazine rifles has not been so widely studied in England as it has abroad, and hence, we do not find the variety of opinion on the matter in English writings as exists on the Continent. Indeed, the number of English officers who have ventured an original public opinion on the matter are extemely few, while others have only made short indefinite references to the subject. No doubt this is due in a great measure to want of facilities for officers to come in contact with these magazine rifles. We do not propose to enter into any details* with regard to the numerous magazine arms that have been invented, but only with regard to their tactical uses, the methods of employing them, and the conditions they should fulfil.

Magazine rifles were first used in the American Civil War with varying success. The faults that existed in them at that time lay principally in their complicated and delicate mechanism and in the paper cartridges then in use. It was only when the solid-drawn cartridge was invented, that magazine rifles promised any advantage in the future, in fact, *a solid-drawn cartridge case is an essential requirement for a magazine rifle.* However, after the American War, the question of using these rifles fell into abeyance.

The Franco-German War re-opened the question, and in 1872, the European Powers set themselves hard at work in experimenting with them and considering how they should be used. But the disadvantages of complicated and delicate

* For a description of some of the principal magazine arms in use, see official "Text Book on Military Small Arms and Ammunition."

mechanism and inferior ballistic qualities* were not as yet overcome. However, the French lead the way, by arming their navy with the Kropatschek under-barrel magazine rifle, in 1878.

While the French experiments were being carried on, the Russo-Turkish War was at its height, and Europe was being vividly impressed with the enormous power of the modern rifle. Magazine rifles were often successfully used by the Turkish cavalry in this war, and the taking of Sfax, in Tunis, in 1883, in which the French Kropatschek magazine rifles were very successfully used, settled the question. The Germans have already armed a large proportion of their troops with magazine rifles, and the French, English, Austrians, and Italians are following suit.

One of the great difficulties that foreign powers have to contend is the expense of re-arming their huge armies with new weapons. Up to comparatively lately, inventors constructed entirely original weapons, which involved a complete re-armament. To avoid this expense, efforts have been directed at utilising the existing weapons abroad, which have since been crowned with great success.

Although Continental armies had been making a regular study of the question of magazine rifles since 1872, yet it was not until 1880 that any real move was made in the matter by our Government. The prevalent idea that our rifle was such a superior one as compared with Continental rifles, might, probably, have been one cause for this delay, but official experiments made in England in 1880 dispelled this pleasant dream, when it was found that our rifle was no better than the French or German rifles, while it was inferior to the Russian one.

Before going any further, we may thus broadly classify as follows the different kinds of magazine rifles that are of any practical use:—

1. Under-barrel magazine rifles, in which the cartridges (about eight in number) are placed in a tube or magazine under the barrel of the rifle.

2. Butt magazine rifles, in which the cartridges (about six in number) are placed in a tube or magazine situated in the butt of the rifle.

3. Hopper magazine rifles, in which the cartridges (about

* These earlier magazine rifles had only light bullets and weak charges. The magazine rifles now in use, take the ordinary rifle cartridge.

ten in number) are placed in detachable hoppers or magazines.

The number of cartridges for each kind of magazine rifle may be taken as a maximum.

There is also another plan, which can hardly be taken as representing or fulfilling the definition that we have given of a magazine rifle. It is an appliance or device called a "quick-loader," to hold about ten cartridges, for the purpose of expediting the loading of the ordinary breech-loader. The quick-loader, when attached to the barrel of the rifle, near the breech, only puts the cartridges in a more favourable position for quick loading than when they are in the soldier's pouch.

The disadvantages of a magazine under the barrel are, that the weight of the rifle is increased; that the base of each cartridge rests on the point of the bullet of the next, and, owing to the jar or recoil of rapid firing, or when ordering arms, or to an over sensitive* or projecting cap, cartridges have exploded accidentally in the magazine, destroying the rifle, injuring the soldier, and making his comrades lose confidence in their weapons. The mechanism is delicate and complicated. The refilling of the magazine is not convenient, as the cartridges have to be worked against a spring that is required for pushing them out again. If the magazine is kept fully loaded for any length of time, this spring is apt to get weakened. The great disadvantages of this kind of magazine, however, are, that we cannot see how many cartridges there are left in the magazine at any given moment, and that they give no means of preventing the men using them if they wish to, because the leaders cannot see if their men are employing them or not, and thus the magazine may be empty just when it is required to be used. Also, owing to the position of the magazine, the balance of the rifle constantly alters as the magazine is being emptied.

The disadvantages of a magazine in the butt are exactly the same as those above, with the additional ones that it carries fewer cartridges, and that it requires a very thick and unwieldy butt. A rifle, however, with this kind of magazine is not subjected to the same variations of balance.

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* It is impossible to manufacture caps of exactly the same degree of sensitiveness, especially if exposed to variations of temperature and deterioration from age.

A further disadvantage of under-barrel and butt magazine rifles is that they must always be carried loaded. What is wanted is a magazine rifle that can be loaded when required; that is a rifle that can be used as a single loader, and at the word of command can be loaded and used as a magazine rifle.

The detachable hopper magazine avoids all these disadvantages. The cartridges in it lie one upon another, so that no explosion can take place in it from the cause stated above, and no man can fix it on the rifle before he is ordered to, without its being seen. As soon as one hopper is emptied, it can be re-filled, even when on the rifle, or it can be rapidly removed and replaced by another filled one. From the position of the magazine the balance of the arm is maintained under all circumstances, but, except in the Lee hopper, which is fixed under the rifle and in its axis, it slightly alters the symmetry of the rifle (see p. 27), the effect of which, however, may be neglected for practical purposes on the battle field.

The best form of hopper is that which is fixed above the rifle so that the cartridges may fall into the breech action by their own weight, without having to be forced in by means of a spring, which has to be used with hoppers that are fixed under the barrel. These hoppers should also be fixed to the left side of the rifle, so as not to interfere with the direct re-loading of the rifle when the hopper is empty, and there is no time to fill or re-place it.

A hopper should carry as many cartridges as possible without inconvenience, and should have a catch to prevent the cartridges, at any moment, from falling into the breech action, when the magazine supply of ammunition is no longer to be drawn on. With the present ammunition 10 rounds is the most that can be conveniently held in a hopper, but with a smaller bore rifle and not such a bottle-shaped cartridge, as at present used, a greater number of rounds could be put into it.

A slot should be cut in the side of the hopper in order to enable anyone to see how many cartridges there are in it at any given moment, while to prevent the men using the magazine supply, until required, when the magazine is fixed, the hopper should, in the Author's opinion, be capable of folding back until it hangs vertically. If then a soldier puts it up to make use of it, without orders, he can be at once checked.

For rifles with a bolt breech-action one great advantage of the hopper magazine is the simplicity of the mechanism required for it. Great difficulty has been experienced in

utilising the falling block breech-action of our Martini-Henry rifle for working a magazine, but lately Capt. C. Greville Harston, late R.M.L. Infantry, has overcome this mechanical difficulty, and his invention is now under trial.

There is a strong opinion abroad, which is also gradually springing up in England, that we made a great mistake in 1870 in adopting the falling block breech-action for our rifle, not so much on account of its unsuitability for magazine purposes, the future use of which was not realized then, but on account of its inferior mechanical power for loading and extracting cartridges. Mechanically speaking, the direct action of a bolt for both loading and extracting is far superior to loading with the thumb and extracting with the indirect action of a lever operated on by a falling block, as we have in our present rifle. We have lately frequently heard from the Soudan, of the want of extracting power that exists in our rifle, for ejecting cartridges that have stuck for any reason. With a bolt breech-action these complaints would not have occurred, unless the base of the cartridge tore away from the body of it, an occurrence which is not likely to occur at any time if a good design and manufacture has been ensured.

Further, a solid-drawn cartridge case is known to require a stronger extractor than the rolled sheet brass ones that we use, as the expansion of a solid-drawn cartridge case when fired, is more permanent than that of a rolled one, and this is another reason for introducing the bolt breech-action in any future rifle for our service.

Arguments have often been used in England against a bolt breech-action on account of the frequent failures of the Prussian needle gun and French chassepôt in the Franco-German War. Metal cartridges were not used with these weapons, and the breech was so badly closed that a large escape of gas occurred when each cartridge was fired. The consequence was that that barrel and breech-action became so fouled that the cartridges could not be put into the barrel, and the working of the bolt became so laborious as to "utterly destroy the steadiness of a man's hand, by sending a tremor up into his arm, which rapidly disqualified him for firing with accuracy." This state of things no longer exists, since a solid-drawn cartridge has been universally adopted abroad, and Continental officers assert that a direct bolt-action tires a man no more than the indirect lever-action that we employ in our rifle.

The only approach that has been made besides Capt.

Harston's late invention, to utilising the falling block breech-action for magazine purposes is in the Owen Jones weapon, in which the striker and spiral spring in the block of the Martini-Henry rifle are replaced by a hammer worked by an ordinary bent spring,* and the cartridges, carried in a detachable hopper magazine, are operated on by a handle, under the butt, the movement and mechanism of which are respectively no shorter and far less simple than that of an ordinary bolt-action.

Thus a bolt breech-action is the most practical method of obtaining a magazine rifle. The best bolt breech-actions yet invented, are those of Mr. Bethel-Burton and of Mr. Lee.

The Bethel-Burton bolt-action, or the Lee, can be used with any of the different kinds of magazines that have been enumerated, and they differ from those used on the Continent, by having the projecting handle at the rear end of the breech, which greatly simplifies it, and the mere action of raising the handle vertically, "cocks" the striker in the bolt, which is operated on by a spiral spring.

These bolt-actions contain only four separate simple parts, which are very easily taken to pieces for cleaning, and put together again by a soldier.† But one of the main features of them is that, when the bolt is pushed home, it is completely covered in, so no dust or dirt can get into its working parts.

The general conditions which a magazine rifle should fulfil are as follows:—

1. Its ballistic qualities (flatness of trajectory, range, and accuracy) should not be inferior to those of the rifles at present in use.

2. It should be capable of use as an ordinary breech-loader, at all times, and of very simply and rapidly allowing the magazine being brought into play, and *vice versâ*, at any given moment.

3. When used as an ordinary breech-loader, it should fire as quickly as the rifles at present in use.

4. The working of its breech-action should load and extract the cartridge coming from its magazine without any assistance of the hand.

5. It should be capable of allowing officers to see if the

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* A spiral spring and striker were adopted for the Martini-Henry rifle as being simpler and better than a hammer and bent spring.

† To take the breech-action of the Martini-Henry rifle to pieces and to put it together again, is by no means an easy operation, and requires special implements for doing so.

men are using the magazine supply, and of seeing how many cartridges remain in the magazine at any given moment.

6. Its mechanism should be strong and simple so as not to require delicate care, and should be able to stand the rough usage of war.

7. Its mechanism should be easily taken to pieces, cleaned, and put together again.

8. Any damage to its magazine should not affect the use of the arm as an ordinary breech-loader.

9. Its mechanism should not be injured by the bursting of defective cartridges, nor allow of any gas escaping from the breech.

10. The cartridges in its magazine should not be liable to accidental explosion, either by the shock of discharge, or during drill, or in case the rifle has an accidental fall, and the bullets in the magazine should not be liable to alteration in shape from the same causes.

11. Its magazine should be capable of being easily and quickly refilled at any moment.

12. Its mechanism should not be liable to be rendered useless by fouling, dust, sand, or rust.

13. Its weight should not be much greater than that of the rifle at present in use.

14. Its magazine should contain *at least ten cartridges*, and as many more as convenient.

The above conditions are completely fulfilled by using a rifle with a bolt breech-action and detachable hopper magazine. By such means the simplicity and weight of the rifle are not altered, while the increase of weight carried on the soldier is insignificant.

In Chapter VII., p. 97, it was pointed out that the modern rifle must not be looked on as a weapon for indiscriminate rapid fire, but as a rapid-loading arm which allows a man to be always ready with it when a favourable moment comes.

The principle on which magazine rifles depend is to suppress the movements of carrying the hand from the rifle to the pouch, taking a cartridge from the latter, moving the hand back to the rifle, and placing the cartridge in the breech. But the time of these movements however, is not very long, and as the magazines of the magazine rifles at present before the public cannot hold more than 10 rounds, the gain is not very great, and only exists while any cartridges remain in the magazine.

Numerous experiments have shown that the continuous fire

of magazine rifles is only more rapid than that of ordinary breech-loaders while any cartridges remain in the magazine, and that there is no general gain in rapidity of fire in filling it again as soon as empty.

This fact is not sufficiently realized in England, because a distinguished cavalry officer stated, only in July, 1884, that "the magazine rifle will probably be the most dangerous arm you can place in the hands of infantry. If you can enable the infantry soldier to discharge forty bullets in a minute, it will be impossible to supply him with ammunition. . . . . ." With the magazine rifles at present in use, it is impossible for a soldier to fire more than half this quantity in the first minute, after which a continuous fire cannot be more rapid than at present with the ordinary breech-loader. Besides, the above quotation presupposes no fire-discipline or control over the men, even at ranges where ammunition can be supplied.

But when we come to consider an intermittent fire in which, during the successive periods of fire, the magazine is used and is re-filled during the pauses, then undoubtedly, the expenditure of ammunition is much greater for magazine rifles than for ordinary breech-loaders.

Consequently, magazine rifles do entail a greater expenditure of ammunition when the fire continues for some time, than ordinary breech-loaders. Therefore, we must trust to prevent any waste by a greater fire discipline on the part of the men; but any very great increase of expenditure, *with the rifles at present in use*, is not ever likely to be the case, for two other reasons—the recoil and the fatigue caused by such a fire.

The recoil question is a very serious one. The energy of the recoil of the Martini-Henry is very excessive, it being 16·6 ft. lbs., or 3·5 ft. lbs. greater than that of the French rifle, and 5·5 ft. lbs. greater than that of the German and Russian rifles. For practical use in the field, when often 150 rounds will have to be fired by each man, the energy of recoil should not exceed a maximum limit of 13·0 ft. lbs.*

* Even this limit may be two high, because in the war of 1870-71, during the operations of the III. German Division round Dreux, on several occasions when the French had been driven out of the woods that they held, many Chassepôt rifles (the recoil of which is about the same as the present Gras rifle used by the French), were found fastened by their slings to the trees to neutralize the effect of the recoil, and in the hurried retreat they were left behind for want of time to unfasten them. According to the war correspondent to the *Manchester Guardian*, on one occasion, over 900 rifles were captured in a wood in this manner by one Prussian company.

An efficacious aimed rapid fire simply could not be kept up with the Martini-Henry rifle from the violence of its recoil.

The fatigue, also, of a long continued, rapid fire, is very great, especially if the recoil is severe. The right shoulder becomes fatigued by the recoil, the muscles of the arms and shoulders (especially the left one) become agitated by a nervous trembling, the rapidity quickly diminishes, in spite of the muscular efforts of the firer, and the fire loses all its accuracy. Experience shows that a continuous rapid fire of any accuracy can only be kept up for about two minutes (see p. 101).

As regards the small-bore rifles of the future (about 0·3 inch bore) the questions as to the increased supply of ammunition required for magazine rifles and the effect of recoil, are practically solved. The recoil with these rifles is said to be very small, and as regards the quantity of ammunition, the latest English regulations on the supply of ammunition, state that with the small-bore bullet *twice* the number of rounds can be carried for the same weight as are now carried.

We have seen that those Continental armies which use the bolt breech-action can easily and efficaciously change their rifles into magazine weapons by the addition of a hopper magazine. This cannot be done, so far as we know as yet, with the Martini-Henry rifle, and so with this rifle all we can do is to try and shorten the time of procuring a cartridge. This may be done in two ways (1), by facilitating the entry of the hand into the pouch, and (2) by the use of quick-loaders (see p. 497).

The pouch requires modification for this purpose. It is covered with a flap, which falls down each time, without, however, preventing the cartridges falling out in rapid movements. The pouches hold too few cartridges, and those which are in them are hard to get at. When we possess a solid-drawn cartridge, a large pouch or bag might be tried, wider at the bottom than at the mouth, pliable enough to adapt itself to the body, and capable of being rapidly opened and closed. When opened, the mouth should remain so, and be large enough to admit the hand freely with a packet of cartridges held in it. A strip of leather fastened round the inside of the mouth of the bag, and sewn only along its upper edge to the latter, will prevent the cartridges falling out while the men are doubling, &c.

A quick-loader is only a kind of pouch, which can be attached to the barrel, near the breech, and from which the cartridges

protrude, so that they can be rapidly seized and withdrawn. These quick-loaders have given very good results, nearly as good as those of magazine rifles, and they have the great advantage of being cheaper, of being capable of being rapidly changed, and of allowing the leaders to see if the men are using them, and, if so, how many rounds they have left in them at any given moment, while they do not interfere with the use of the bayonet. These quick-loaders can be well used with the Martini-Henry rifle, and they have been adopted by the Russians in preference to a removable magazine, probably on the score of economy, as they have only lately re-armed their infantry with the Berdan rifle.

The necessity for using magazine rifles or quick-loaders in the future, will be best seen by considering the tactical use to which they will be put, and, although we shall only refer to magazine rifles, yet the following remarks apply equally well to the use of quick-loaders.

The tactical use of magazine rifles laid down by English writers, is not at all in accordance with Continental ideas. In England, it is considered that they should be used at short ranges only. We constantly see, in English writings, that magazine rifles are adapted for close quarters, for the defence of woods, villages, bridges, defiles, barricades, ditches of fortifications, &c., and that they should form the armament of such special troops as would only be engaged at close quarters, such as cavalry, engineers, seamen, &c.

On the Continent, on the other hand, the universal opinion is that magazine rifles should be used at all ranges, *if the objectives fired at are suitable to the range.* The tactical use of magazine rifles abroad is entirely based on what has been said in Chapters XII., XIV., and XV.

It has been frequently stated, that the moral effect caused by an efficacious fire is greater, as the time in which the losses are effected is less, that is according to the suddenness and rapidity with which they are inflicted.

The objectives usually fired at in war, are very variable and mobile, and are often only seen at intervals, and it is in order to pour a rapid fire on these short appearances, that a magazine rifle is required to inflict the greatest loss possible in the shortest time.

"Magazine rifles have the undoubted advantage of allowing at any given instant, and especially, at the decisive moment of the fight, the enemy to be overwhelmed with a mass of projectiles."

If fire is to be opened on any given objective at any range, then while the fire lasts its useful effect should be as great as possible, and in Chapter VII. we saw that rapidity of fire increases this useful effect, and it is only by the use of magazine rifles that the greatest possible mass of lead can be directed on an enemy at any given moment. The greater the useful effect, the greater will be the moral effect on the enemy, and hence the power of being able to inflict sudden losses on an enemy will go far towards attaining victory.

"Now-a-days, from the moment when his masses arrive on the field of battle, we try to prevent the enemy coming to within the short distances. Hence all the power of the fire of the troops ought to be utilised as early as possible, in order to take away as soon as possible from the enemy the vigour that it is necessary for him to possess for the close fight."

We can only obtain decisive results by the quantity, as to time and place, as well as by the quality, of the fire. Therefore, we must try and obtain both. Quality of fire can only be obtained by training in peace time, and quantity of fire, as to time and place, by means of magazine rifles.

We have already pointed out, on p. 348, the necessity of the fire having pauses in it, for purposes of control, and in order to give it an offensive aspect. The necessity for this manner of conducting the fire is increased for the tactical use of the magazine rifle. By making the men re-fill their magazines when empty, the necessary pauses are easily obtained, and the increased rapidity of the fire while it lasts, must give the fire a very terrible character. Although the magazines may be full, they should only be brought into play against objectives suitable to the range; they would not, on the other hand, be used when men are allowed to fire while advancing.

Thus, with magazine rifles, the power of the fire is increased during the successive periods of intermittent fire, and, if too great a rapidity of fire is avoided, the gain in rapidity does not cause any loss in accuracy.

The quality of the rifles used in a collective fire can only be appreciated by the numerical expression of the effect of its fire over the whole depth of the ground grazed by the cone of dispersion. This effect can be shewn, either by graphical curves, or by the number of hits made on a series of equi-distant targets. When men are tired and fatigued, the greater the number of rounds they can fire under the same conditions, the better and more continuous will be the numerical expressions representing their dangerous zones, and the theoretical destructive effects

of the fire of two different rifles will be proportionate to their rapidity of fire, and for this reason—for a fire lasting one to two minutes, magazine rifles will have a great superiority. From the smoke which usually covers the opposing sides, aim can only be taken at the line of intersection between the smoke and the ground. "In these conditions, it is no longer a question of aimed or regulated fire, but the destructive effect of the fire will depend on the quantity of bullets fired during each halt; a magazine rifle will then have the superiority, which will be all the more marked if the calibre adopted permits the soldier to carry, without increasing his load, one-fourth more of ammunition, which he will be able to expend during this phase of the attack."

With magazine rifles, the fire should essentially be carried out by means of volleys, and not by independent firing, to prevent the magazines being too rapidly emptied, but the fire should be made to increase gradually in rapidity as the range decreases, and as the efficacy of the fire, consequently, becomes more certain.

The following extract from a lecture on "Magazine Rifles," by Colonel Fosbery, V.C., shows the great value of volleys with magazine weapons at even short ranges:—

"I remember hearing a Confederate officer relate his first experience (in the American Civil War) of the Spencer magazine rifle, and though the name of the place has, I am sorry to say, escaped my memory, the other details have not.

"He stated that the Federals had occupied and stockaded a strong position on the top of a hill, commanding, if I recollect right, the passage of one of their great rivers, a position from which it was necessary they should be expelled if possible at once.

"A strong storming party was accordingly formed, and assembled at nightfall in a woody bottom at the foot of the hill. When the moon rose, they commenced silently to ascend, until at last they saw just above them the long black parapet against the sky-line apparently without a defender.

"On some sound being made, however, the alarm was given, and in an instant the parapet was lined with heads, and a volley poured into the assailants at close quarters, which was almost instantly followed by a second. This was a war of surprises, and coming to the conclusion that their enemies had double barrels and must now re-load, the stormers cheered and rushed at the work; but they had reckoned without the Spencer. Five more volleys followed the first two without a

second's intermission, and the broken remains of the party took refuge in the bottom to attempt that post no more.

"On another occasion a Federal brigade, which had already suffered severely in action, and was reduced to a fraction of its original numbers, came in sight of a vastly superior body of the enemy, which instantly made preparations to attack, and moved down on them full of confidence, as my informant said, drums beating and colours flying.

"For a moment everyone thought that all was lost. The officer in command, however, understood his business and knew his weapons. He ordered the magazines to be filled, the men to take such cover as they could find and wait for the word of command. Nearer and nearer came the enemy, and still the thin line waited in dead silence. When, however, they got within a hundred paces, the order came out sharp and clear, and volley after volley from the repeaters mowed them down in an instant. The ranks fell one over the other in heaps, and the survivors, panic-struck at this sudden and unexampled slaughter, turned and fled, leaving the spoils of war to the enemy they had too soon despised."

For savage fighting, where the enemy rushes on in thick masses to the attack, the fire of magazine rifles at short ranges would be invaluable.

With regard to the more detailed use of the magazines in action, among the supply of ammunition carried in the valise should be two filled hopper magazines (or quick-loaders for the Martini-Henry rifle), each of which should hold at least 10 rounds. These would be taken from the valise before entry into action, and one attached to the rifle and the other to the waist-belt. The one attached to the rifle would be re-filled again and again as it was emptied, so as to steady the men and to cause pauses in the fire. Just before the assault the leaders would try and preserve both magazines full, so as to get a rapid fire of 20 rounds at least, just at the moment of the assault, by rapidly changing the magazines, throwing the empty ones on the ground, which can be collected again afterwards. Men cannot stand much more than 20 rounds of such rapid firing.

Naturally during an attack, many hopper magazines would be lost or injured by the enemy's fire, and to make up these deficiencies an extra supply of filled hoppers should be carried in the field in the ammunition supplies.

Having shown the necessity for magazine rifles as an armament for infantry, we may well wonder why they have not been adopted before or more generally introduced than

they have been. Till quite lately, before the introduction of the hopper magazines, the adoption of magazine rifles entailed a complete re-armament, and consequently a vast outlay of money which no nation cared to face. Besides which, the earlier magazine rifles, "only partially fulfilled the requirements, from a practical point of view, of such weapons. Their loading was a difficult operation; their different parts were complicated; and they were not sufficiently solid. Dust, sand, and rust could easily, at a critical moment, prevent the working of the mechanism, and as there was considerable difficulty in taking them to pieces, cleaning, and putting them together again, a considerable time elapsed before the weapon was ready to fire again. Further, it was necessary to make use of very small cartridges to place a sufficient number in the magazine; consequently the weight of the powder charge was so small, with regard to that of the bullet, that the muzzle velocity was low and the accuracy poor. On the other hand, the position of the centre of gravity being changed with each shot fired, the firer was put out and fired badly. Lastly, these magazine rifles only allowed of a rapid fire when used as such; if used as ordinary breech-loaders, they could only be fired very slowly."

Thus till lately the fault of magazine arms has been their complicated and delicate mechanism and their high trajectory, from their light ammunition (caused by a light bullet and small charge), which did not give a sufficient velocity and sectional density to counteract the effect of the resistance of the air on the light bullets.

These faults do not now hold good as arguments against the introduction of magazine rifles, because by means of hopper magazines, existing rifles (except the Martini-Henry rifle) and ammunition can be readily made use of. But even with the old weapons good results have been obtained, as we have already shown, and the Comte de Paris, who took part in the American Civil War, stated with regard to the Spencer magazine carbine:—"It is an excellent weapon, the use of which spread more and more in the Federal army. Extraordinary examples of defence, due to the rapidity of fire of this weapon, can be quoted, and the Federal infantry regiments who tried them found them very good." But even in spite of this they did not find advocates until the solid-drawn metal cartridge case was invented.

One other great point must not be overlooked in making magazine rifles the future armament of infantry, viz., the moral strength it will give to the side using them.

General Brialmont writes:—"It is incontestable, however, that the magazine rifle augments the confidence of the soldier at the decisive moment which precedes the assault, and that this effect ought not to be disdained in war, where *moral* plays so great a *rôle*."

A writer in the German military paper, the *Militär Zeitung*, of the 17th February, 1883, states:—"The infantry which is first armed with a magazine rifle, *and whose instruction has been directed according to the rules required for the good employment of this arm*,* will be certain to possess, when opposed to an enemy, a sentiment of marked superiority, not only on the battle-field, but also in all the enterprises of minor warfare."

It is thus very certain that a magazine rifle will assure to any infantry which is armed with it, such a moral superiority, that as soon as any one great Power will have adopted it, all the others will be forced to follow its example; † and we have seen that a magazine rifle will give materially, as well, a tactical superiority to the troops who make use of it against an enemy armed with the ordinary breech-loader.

Hence everything points to the necessity of arming all troops with magazine rifles or carbines as the case may be.

If we only deal with the fire of magazine rifles at short ranges, we may well doubt the advantage of any change of armament.

What is expected from a rapid fire is to destroy the *moral* of the enemy by sudden losses caused by an intense fusilade, and to break his strength and demoralise him by the losses which this fusilade will produce.

No doubt the whistle of passing bullets profoundly impresses men, but there is a limit to this. Whether a firing line receives 1,500 or 2,000 bullets a minute, the impression at the moment will be the same, especially as the men in the firing line are firing as well, and the noise that they make is so great that any superiority in the enemy's fire would not be noticed. This is particularly the case at the closest ranges.

The losses suffered is the real factor which will destroy both the *moral* and strength of either side. But the men firing are being fired on, which, at short ranges, destroys the accuracy of their fire. It has frequently been noticed in war

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* These rules are strictly in accordance with the principles laid down in Chapter XV.

† Germany has adopted it, and France, England, Italy, and Austria are now doing the same.

that losses decrease as the ranges diminish, and it must never be forgotten that want of efficacy of the fire of one side increases the *moral* of the opponent.

Short-range fire also is one of great rapidity, but rapidity of fire, beyond a certain point, does not necessarily increase the losses of the enemy. In the experiments made in France on magazine arms it was found that, for the same time of firing, the effect produced was in inverse ratio to the number of bullets fired. A fire of 8 to 10 shots a minute always gave a very superior useful effect to that which expended 16 to 18 cartridges in the same time. Thus great rapidity of fire loses in one respect more than it gains in another.

Thus as far as short-range fire is concerned, the opponents to magazine weapons may have some grounds to fight on, but we must always remember that the demoralisation of the enemy is not the work of a few seconds, and hence it will not be gained by a short intense fire at short ranges, especially if the previous losses have been few. *The enemy must be demoralised before the short ranges for rapid fire are reached*, and to do this most effectually we have sought to show, that magazine rifles must be used at all ranges at which fire is to be opened, especially as by the time the shortest ranges are reached, the magazine may be empty and there may not be time to re-fill them.

The German official regulations on the use of the new magazine rifle, says:—"The magazine gives to the soldier a continual reserve of ammunition, by means of which he can, at any instant, be ready to fire. This reserve will always be assured, if a discreet and judicious use is made of it, and if advantage is taken of all occasions to refill it. The soldier ought never to forget that his new rifle increases the necessity for an absolute discipline of the fire, and that it is intended to produce, not only a superficial acceleration in the fire, but also a superior efficacy of fire." To ensure this, a peace education and training is absolutely essential.

A French writer in the *Revue Militaire de l'Etranger*, for 15th March, 1887, after an exhaustive article on the new German magazine rifle, and after examining German official and private opinions as to its use, thus concludes:—"It is necessary, therefore, to conclude that the new armament will not lead to any tactical revolution. *Its employment will increase the necessity of a strict discipline in the fire*; it will equally force both the assailant and the defender to preserve, more carefully than in the past, their reserves for the decisive instant. But,

after all, the procedure for supplying the front (*i.e.*, shooting line), for bringing up the reserves in mass and under cover, in order to assure superiority of numbers at the desired place and moment—all these tactical methods, which the invention of the breech-loading rifle had profoundly modified, and even renewed—will remain the same to-day, as in the past, without being any way affected by the adoption of the magazine rifle . . . Its adoption is only a progress of a secondary order which has the characteristics of a transitory measure, perhaps in paving the way for a small-bore rifle, the study of which is only a question of time, and which the necessity for an increase in the number of cartridges will impose." How true these latter words are can be seen by the proceedings and recommendations of the English Magazine Rifle Committee.

A German writer in the *Militär Wochenblatt* says:—"If the new rifle has any advantages, it offers no essential property which modifies the principles of employing rapid-firing breech-loading rifles."

NOTE.—The reader is advised to consult the article on "*La question du fusil de guerre*," which appeared in the *Revue Militaire de l'Etranger* for 30th May, 1887 (No. 671) for the latest ideas on magazine rifles. This article reached the author's hands too late to be embodied in this work.

Note.—(See p. 468).—One of the great faults of the English system of musketry training is the shortness of the course. Skill in shooting requires constant practice, as it is an art easily forgotten. Our men only get a few days' shooting in the year. This is radically wrong, and in these few days they are hurried through a complex course of different kinds of firing, and are expected to be perfect in each kind after one trial only! What a contrast to the German system! Where our men get but a few days' training, covering a complete course, in Germany three months is considered none too long merely to lay a firm basis only of the recruit's instruction—a basis that can be built upon later. As regards target practice, the German idea is to teach a recruit to shoot well at short distances, and in his first year he is only allowed to shoot at ranges of 100, 150, and 200 mètres. In England, on the other hand, the object seems to be to push on the recruit to long-range firing as speedily as possible, for on the eighth day he is made to fire at 500 yards, a distance which the German recruit is not allowed to attempt before his second years' service. The number of points (95) required to pass a recruit into the second class is too low, and might be obtained with forty misses out of eighty shots without getting any bull's eyes. The attempt to teach aiming-drill up to 600 yards in two days, and to judge distances up to 800 yards in six days can hardly be expected to yield satisfactory results. In Germany the military authorities are satisfied if the recruit can judge distances up to 200 mètres within 50 mètres in twelve weeks.

The first object of infantry is to hit, the second is to hit, and the third is to hit. This can only be ensured by a constant and prolonged training both in target practice and in fire discipline, and not by a few days firing only.

APPENDIX I.

THE EFFECT OF ATMOSPHERIC CONDITIONS ON THE FIRE OF RIFLES.

A bullet must displace the particles of the atmosphere during its passage through it. Consequently the trajectory of a bullet is affected by variations in the density or weight of the atmosphere. These variations are caused by changes in the temperature, in the amount of moisture, in the local pressure of the atmosphere, and in the altitude above sea level. Any variation in the density of the atmosphere must affect the amount of retardation experienced by the bullet. The longer the range and the lower the velocity the greater this effect will be, while at very short ranges and with high velocities the effect is scarcely noticeable. Certainly, in war a barometer and thermometer cannot always be consulted, but it is none the less desirable that officers should realise what effect atmospheric conditions may have on the flight of bullets, especially so as it will be found that variations of temperature have the greatest effect, particularly when such variations are so large that they are easily appreciated by their effect on the senses.

The less the density of the air, the less is the amount of retardation, the quicker will the bullet reach its destination, and the greater will be the range for a given elevation, or in other words, for a given range the less will be the elevation.

We will consider the subject under the following headings:

1. Barometric pressure and altitude above mean sea level.
2. Temperature and atmospheric moisture.
3. Wind.
4. Condition of the powder charge.

1. Barometric Pressure and Altitude.

The mercury column of a barometer is kept up by the atmospheric pressure. The higher we go above the sea level the less air we have above us, and the less is the pressure, and consequently the less is the density of the air, supposing for the moment that the temperature remains constant.

From the following formulæ we can obtain very nearly the normal barometric pressure corresponding to a given altitude above sea level, and *vice versâ*, for a mean temperature of 50° F., between the temperatures at sea level and at the observer.

For an ordinary barometer we have the mean rise in feet per inch fall of barometer at an altitude of A feet.

$$= 909{\cdot}2 + 0{\cdot}0166\ \text{A.} + {\cdot}0000001\ \text{A}^2 = M \text{ suppose.}$$

Then normal corrected height of barometer at altitude A feet.

$$= 30 - \frac{\text{A}}{\text{M}}$$

If the sum of the temperatures at the sea level and the observer is greater than 100° F., decrease the given altitude by $\frac{1}{1000}$ part for every degree above 100° F.; if it is below 100° F., increase the given altitude by the same proportion for every degree below 100° F. before using it in the calculations.

The mean rise in feet per inch fall of barometer at corrected normal barometer reading B inches.

$$= 909{\cdot}0 + 14{\cdot}5\,(30 - \text{B}) + \tfrac{1}{2}\,(30 - \text{B})^2.$$
$$= N \text{ suppose.}$$

Then altitude A corresponding to normal barometer pressure B inches = N (30 — B).

If the sum of the temperatures at sea level and at the observer is greater than 100° F. increase the altitude found by $\frac{1}{1000}$ part for every degree F. above 100° F.; if it is below 100° F. decrease the altitude found by same proportion for every degree F. below 100° F.

2. Temperature and Atmospheric Moisture.

A decrease in the temperature of the air makes the air denser and *vice versâ*. Consequently, the natural decrease of temperature which takes place as we rise in altitude tends to neutralise the diminution in the density of the air due to this altitude.

Aqueous vapour or moisture reduces the density of the air.

Its amount, called the humidity, depends on the temperature. When dew is deposited, the air is said to be saturated, or to contain 100° of humidity. But the extreme variations in the density of the air, caused by the variations of the moisture in it, are so small compared to those produced by changes of temperature, that, for military purposes, no great error will result if the air is considered as being $\frac{2}{3}$rds saturated.

Remarks.

We will now consider the combined effects of altitude, barometical pressure, temperature, and moisture.

The reduction of atmospheric pressure (as measured by a fall in the barometer) has a very similar influence upon the motion of the bullet to that which would be produced under ordinary atmospheric conditions if an addition were made to the weight of the bullet without enlarging its sectional area or lessening its muzzle velocity. Professor Bashforth's Tables are calculated on the supposition that the air is dry, and weighs* 534·22 grains per cubic foot at a temperature of 62° F., and with a barometic pressure of 30 inches. If the rise and fall of the barometer is only considered, the sectional density need only be multiplied by

$$\frac{30}{\text{height of barometer in inches}},$$

and the rest of the calculations worked out as before. If the temperature and moisture are also to be taken into account, then it is necessary to ascertain the weight of a cubic foot of the air in which the bullet is fired, by means of meteorological tables, such as Glaisher's. In this case the sectional density must be multiplied by the factor

$$\frac{534{\cdot}22}{\text{weight of cubic foot of air in grains}},$$

instead of the factor given above.

If strict accuracy is not required, a close approximation to the weight of air may be obtained by means of the following table, given by Lieut. Zalinski, of the United States Army. The barometer is supposed to be at 30 inches, and moisture at 66 $\frac{2}{3}$rds per cent. of saturation (*i.e.*, the air is $\frac{2}{3}$rds saturated).

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* Relative densities are represented by relative weights.

TABLE I.

Temperature.	Weight of a cubic foot of Air.	Mean change of weight for each one-tenth inch fall or rise in barometer.	Mean change of weight for 1° F. rise or fall in temperature.	Mean decrease of weight with humidity at saturation.
Fahr.	Grains.	Grains.	Grain.	Grains.
— 30°	647	—	—	—
— 20°	633	2·1	1·4	—
— 10°	619	2·1	1·4	0·10
0°	605	2·0	1·4	0·20
10°	592	2·0	1·3	0·35
20°	579	1·9	1·3	0·53
30°	567	1·9	1·2	0·76
40°	555	1·8	1·2	1·03
50	544	1·8	1·2	1·42
60°	532	1·8	1·2	1·96
70°	521	1·7	1·2	2·66
80°	509	1·7	1·2	3·60
90°	497	1·7	1·2	4·83
100°	485	1·6	1·2	6·50
110	473	1·6	1·2	8·32

From this table three things are apparent :—(1) That an average change of 15·0° F. of temperature is equivalent to a change of 1 inch in the height of the barometer ; (2) that the usual small changes in the height of the barometer at any given spot on the earth's surface affect the density of the air so slightly that they may be neglected ; and (3) that the effect of temperature, which often changes several degrees during the day and during different seasons, may frequently be too great to be neglected.

Although 15 is the average number of degrees F. that have the same effect on the density of the air as 1 inch of the barometer pressure, yet the real number of degrees is very nearly expressed by the following formula.

Number of degrees F. equivalent to 1 inch of the barometer, at temperature T°. F.

$$= 15 + \frac{1}{30}(50-T)$$

The method already stated of ascertaining the effect of of atmospheric conditions by means of Bashforth's Tables is not applicable for ordinary purposes. The following formulæ are well adapted for this purpose, and give results within the errors that exist between single cartridges.

Effects of air pressure as measured by the barometer. From tables given in Walsh's *The Modern Sportsman's Gun and Rifle*, in the American musketry regulations, and other works, the following formula has been deduced.

Let R = range in yards.
B = normal barometer reading in inches.
b = local " " " at moment of firing.

Then B—b = local variation of barometer pressure.

The normal increase of range due to normal pressure B

$$= \frac{1{\cdot}5\,(30-B)\,R}{100} = \frac{R}{1000} \times 15\,(30-B)$$

The increase of range at moment of firing due to local pressure b

$$= \frac{1{\cdot}5\,(30-b)\,R}{100} = \frac{R}{1000} \times 15\,(30-b)$$

Hence the increase of range in yards due to a change of (B—b) inches of the barometer

$$= \frac{R}{1000} \times 15\,(B-b)$$

or increase of range due to change of 1 inch in the barometer

$$= \frac{15\,R}{1000}$$

In the above formulae, a *plus* result means an increase of range, and a *minus* result a decrease.

As (B—b) rarely exceeds $\frac{3}{4}$ths of an inch, *the alteration of range, due to local variations of the barometer, is so small that it can be neglected in the field, and hence it will generally be sufficient to take only the normal height of the barometer at the locality of firing*, which depends principally on the altitude above sea level.

Effect of Altitude.

On p. 514 we find the formula for calculating approximately the number of feet rise in altitude equivalent to a fall of one inch of the barometer.

Hence, if A be the altitude in feet above the sea level, and M be the equivalent number of feet to 1 inch of the barometer, then the increase of range due to A feet of altitude.

$$\frac{15\,A}{M} \times \frac{R}{1000} = \frac{A}{p.} \times \frac{R}{1000}$$

$$\text{Where } p = \frac{M}{15} = 60{\cdot}6 + {\cdot}0011\,A.$$

From the foregoing we see that when the sights of a rifle are graduated for use at the sea level, any considerable rise above the sea level causes the engraved elevations to be too great for the ranges marked against them. This is an important fact, often overlooked; for example, in Afghanistan and South Africa, our troops were employed at elevations over 3,000 feet above the sea level, which caused a considerable increase in the range engraved for each elevation (see example p. 523).

Effect of Temperature.

The temperature decreases about 1° F. for every 300 feet of altitude, and on p. 517 the formula has been given for ascertaining the number of degrees F. which have the same effect on the flight of a bullet as a rise or fall of one inch of the barometer. From this we find that it varies from 16 degrees F. at temperature 32° F. to 13·4 degrees F. at temperature 100° F., the mean being 14·7 degrees, or 15 degrees nearly.

Hence, 15 degrees F. cause an alteration of range equal to

$$\frac{15{\cdot}R}{1000}$$

or the alteration of range due to a change of one degree F in the temperature is equal to

$$\frac{R}{1000}.$$

Consequently, if T be the temperature F. for which the

rifle is sighted, and t be the temperature F. at the moment of firing, then alteration of range due to (t—T) degrees F.

$$= \frac{R}{1000}(t - T).$$

A *plus* result means an increase of range, and a *minus* result a decrease.

T and t can be taken as any two temperatures, if the difference of effects of these two temperatures is required.

The temperature of the air often varies very considerably during a single day, and still more so between the different seasons of the year. The annual variation may extend from 0° F. to 110° F., or through a range of 110 degrees, which must have a very marked effect on the proper elevation to be used for the same range at different seasons of the year.

3. Wind.

In considering the action of the wind upon the flight of a projectile, we have to determine the probable effect not only upon elevations, but upon deflections. To do this we must *assume that the wind remains uniform in force*, for with a variable wind we cannot make any calculations.

The force or pressure exerted by a wind is in a direct connection with its velocity, and consequently the force of wind is designated by its velocity in miles per hour or feet per second. The connection beween the velocity and pressure of wind is shewn in the following table :—

TABLE II.*

Velocity.		Pressure on one square foot in lbs.	Description.	Velocity.		Pressure on one square foot in lbs.	Description.
Miles per hour.	Feet per sec.			Miles per hour.	Feet per sec.		
1	1·47	0·005	Hardly perceptible	20	29·30	1·968	Fresh breeze
				25	36·67	3·075	Stormy ,,
2	2·93	0·020		30	44·01	4·429	Moderate gale
3	4·40	0.045	Just perceptible	40	58·68	7·873	Fresh ,,
4	5·87	0·080	Light air	50	73·35	12·300	Strong ,,
5	7·33	0·123	Light breeze	60	88·02	17·715	Heavy ,,
10	14·66	0·492	Gentle ,,	80	117·36	31·490	Storm
15	22·00	1·107	Moderate ,,	100	146.66	49·200	Hurricane

* Pressure in lb per square foot is equal to the velocity in miles per hour squared, divided by 200.

As the direction of the wind varies, marked changes occur in its relative effects in both the range and the deflection of the projectile. To arrive at any satisfactory conclusion, it is necessary to resolve the wind force into two component forces, one acting in the direction or plane of the fire, and the other at right angles to it. We can then make the necessary allowances as if each of these two forces acted independently.

The component of the wind force acting in the plane of fire is called *accelerating* if the wind is from the rear, as it increases the range for a given elevation; and it is called *retarding* if the wind is from the front, as it decreases the range.

This component acting at right angles to the plane of fire is called *deviating* or *deflecting*, and makes the bullets go to the right or left as the wind is from the left or right respectively of the plane of fire.

The direction of the wind can be obtained by observing its effects on the smoke, on trees and grass, on flags, or upon any exposed portion of the body (as the face).

The force of the wind is usually designated in miles per hour, and can be obtained accurately from an instrument called an anemometer. But it can be approximately judged by observing the manner in which boughs of trees, and flags are affected; also by the sensations produced upon the face and other portions of the body. If such estimates are compared with anemometer readings, they will be made with very fair accuracy.

Now suppose the direction of the wind to be denoted by the numbers on the face of a watch, the watch being so held that the hour XII points towards the target, and the hour III to the right hand. A wind from the front (*i.e.*, from the target) is then a XII o'clock wind; a wind from the back, a VI o'clock wind; a wind directly from the left and across the line of fire, a IX o'clock wind; and so on.

The following table gives the approximate proportions of the two component forces of the wind in terms of the greatest effect of the wind when blowing either up or down the line of fire, or directly across it, as the case may be.

TABLE III.

1	2	3	4	5	6	7
	For a Wind from the Rear.			For a Wind from the Front.		
Direction.	Accelerating	Deviating to the Left.	Deviating to the Right.	Retarding.	Deviating to the Left.	Deviating to the Right.
XII	—	—	—	1	0	—
XII½	—	—	—	1	¼	—
I	—	—	—	⅞	½	—
I½	—	—	—	¾	¾	—
II	—	—	—	½	⅞	—
II½	—	—	—	¼	1	—
III	0	1	—	0	1	—
III½	¼	1	—	—	—	—
IV	½	⅞	—	—	—	—
IV½	¾	¾	—	—	—	—
V	⅞	½	—	—	—	—
V½	1	¼	—	—	—	—
VI	1	0	0	—	—	—
VI½	1	—	¼	—	—	—
VII	⅞	—	½	—	—	—
VII½	¾	—	¾	—	—	—
VIII	½	—	⅞	—	—	—
VIII½	¼	—	1	—	—	—
IX	0	—	1	0	—	1
IX½	—	—	—	¼	—	1
X	—	—	—	½	—	⅞
X½	—	—	—	¾	—	¾
XI	—	—	—	⅞	—	½
XI½	—	—	—	1	—	¼

If the *data* be known that are produced by a wind having a velocity of one mile an hour, then those for other velocities are found by simple proportion. No satisfactory *data* have been obtainable for the deflection of a Martini-Henry bullet, due to a side wind. Those for the French rifle, with service cartridge (80 grains of powder and 386 grains bullet), have been given on p. 40. The following table gives the deflection for the American rifle, with service cartridge (70 grains of powder and 500 grains bullet), for a side wind moving at one mile an hour.

TABLE IV.

Range in Yards.	100	200	300	400	500	600	700	800	900	1,000
Deflection in inches	0·33	1·5	2·5	4·0	5·5	7·5	10·0	13·0	17·0	22·0

The effect of the wind upon the range has not yet been satisfactorily solved; but from computations based upon the most reliable *data* of the American rifle, it would appear that a wind with a velocity of one mile an hour will produce upon the range, at all distances, the same effect as would follow from a change of $2\frac{1}{2}$ degrees in the temperature. If this rule can be taken as also applying to the English rifle, the alteration in range for different head or rear winds can then be obtained from the formula for the effect of temperature given on p. 518, a little more than one-fourth the changes in range, for a rise or fall of 10 degrees F., being the change in range produced by wind moving at one mile an hour.

Hence, if V be the velocity in miles per hour, the

$$\text{alteration in range} = \frac{V}{4}\ \frac{R}{100} \text{ for a head or rear wind.}$$

Or the alteration in range for any wind,

$$= \pm f\ \frac{10 \cdot V}{4}\ \frac{R}{1000}$$

Where f is a factor taken from column 2 and 5 of Table IV, and it is + for a rear wind and — a head wind.

4. The Condition of the Powder Charge.

For information on the point see pp. 31 to 35. It is only desired to point out here the fact that atmospheric conditions

do influence the condition of the powder charge, and, consequently, the muzzle velocity of the bullet.

RÉSUMÉ.

Now combining the formulæ that have been given, and supposing E to be the elevation required, we have

$$E = R - \frac{R}{1000}\left\{(t-T) + 15\,(30-b) \pm f\,\frac{10\cdot V}{4}\right\}$$

$$\text{or } E = R - \frac{R}{1000}\left\{(t-T) + \frac{A}{p} + 15\,(B-b) \pm f\,\frac{10\cdot V}{4}\right\}$$

Where $p = 60\cdot6 + \cdot0011\ A$.

Let us take an example, as follows:—

Altitude 3,000 feet above sea level.
Normal Barometer 26·77 inches.
Barometer at time of firing 26·27 inches.
Temperature of air 90° F.
Temperature for which the rifle is sighted 60° F.
Range 1,500 yards.
Wind from rear, a gentle breeze with velocity of 10 miles an hour.

By first formula—

$$E = 1500 - \frac{1500}{1000}\left\{(90-60) + 15\,(30\cdot00-26.27) + \frac{100}{4}\right\}$$

$$= 1500 - \ 1\cdot5 \left\{30 + 56 + 25\right\}$$

$$= 1500 - \left\{45 + 84 + 37\right\}$$

$$= 1500 - \ 166 = 1334 \text{ yards.}$$

By second formula—

$$E = 1500 - \frac{1500}{1000}\left\{(90-60) + \frac{3000}{64} + 15\,(26\cdot77-26\cdot27) + \frac{100}{4}\right\}$$

$$= 1500 - 1\cdot5\left\{30 + 47 + 8 + 25\right\}$$

$$= 1500 - \left\{45 + 71 + 12 + 37\right\}$$

$$= 1500 - 166 = 1333 \text{ yards.}$$

This last formula shows us the separate effect of each cause of error, and we see that the alteration of range due to a local change of half an inch in the barometer is small to that which may be caused by local changes in the temperature, and hence the expression 15 (B — b) may be left out of the formula. In the above example, had b been greater than B, or T greater than t, or if the wind had been a head wind, the corrections for these would have had a *minus* sign inside the bracket, and a *plus* sign when the bracket was removed. If the wind had been at an angle to the direction of the fire, f would have been a fraction instead of being equal to ·1, and the bullet would have been deflected.

Those who take an interest in their profession are recommended to work out the above formulæ for different ranges, barometric pressures, altitudes, and changes of temperature, taking t—T as representing this last change in degrees F.; they will then have impressed on their minds the probable effect of the different conditions of the atmosphere, remembering that a *plus* answer means an increase in range, and a *minus* means a decrease.

In the field, a pocket aneroid, with an attached thermometer, would give all the *data* necessary for an approximate calculation for the alteration of range to be expected in different localities, when using the engraved elevations on the back-sight.

The following remarks were made by the *Field* newspaper of the 3rd March, 1888, on the above paper, extracts of which was sent to the editor:—

We have received from Captain Mayne, R.E., the above mathematical paper, the formulæ of which seems admirably adapted for facilitating the estimation of the change in length of the range of projectile that results from alterations in the condition of the atmosphere. The process appears to be based on the principle that the atmospheric resistance to the passage of projectiles through the air being very nearly in the ratio of the cube of their velocity, any decrease of density in the atmosphere will lessen the retardation of the bullet in a corresponding degree, and thus tend to lengthen the range in the ratio of the cube-root of the reduction of weight in the air. Thus, when the barometric pressure falls from its ordinary standard of 30 in., and drops to 29 in., it is equivalent to a reduction of 3⅓ per cent. in atmospheric retardation; the cube root of 3⅓ is almost exactly 1½, and each fall of an inch in the barometer consequently corresponds with an extension in range of 1·5 per cent., or of 15 yards in 1,000. Hence this number 15 forms a very prominent feature in the above formulæ. Some of our readers, however, will

probably not be familiar with the mathematical process by which Captain Mayne's argument is worked out, and we therefore take the liberty of further illustrating it by means of a few examples in ordinary arithmetic

Let us in the first instance take the case of a simple reduction in barometric pressure, and suppose the riflemen to be up in the mountains at such a height that the barometer stands at 25 in. instead of 30 in. The difference between 30 and 25 being 5, let us multiply the number 15 by this 5 in. fall, and we have 75 as the number of yards increase on a range of 1,000 yards; or, in like proportion, 7·5 yards on 100, 30 yards on 400, and so on.

Again, supposing the temperature to be high and the barometer low, then a further reduction in atmospheric resistance occurs, a difference of 15° Fahr., being equivalent to an inch on the barometer. In the absence of direct knowledge of the temperature when the rifle was sighted, 60° may be assumed as being about the English average; and consequently, when the thermometer marks 90° there would be a difference of 30° to allow for, which would be equivalent to 2 in. barometric fall. But it is needless to convert it in this way, as the number of degrees of difference may be added direct to the previous total. Thus taking 75 yards to be the increase on 1,000 yards range, as in the previous example, the addition of 30 for increase of temperature would raise the number to 105 yards.

Where no barometer is at hand, but the altitude is approximately known, 1,000 feet elevation may be assumed as equivalent to an inch barometric fall; so that at an height of 5,000 feet the 5 would serve as examples. At greater elevation than 5,000 feet the result would be slightly over-estimated, but not very materially.

Next, as to the effect of the wind, its velocity may be multiplied by 15, and divided by six. Thus, suppose a 6 o'clock wind of 10 miles an hour. This 10 may be taken as the multiplier of the 15, and on being divided by 6 would give 25 as the result.

The combined effect of low barometric, high temperature, and favourable breeze would then be shewn as follows :—

	Increase in 1000 yards.
5 in. fall of barometer (5 × 15) ..	75 yards
30° rise in temperature	30 ,,
10 mile breeze (15 × 10 ÷ 6)	25 ,,
Total increase of range	130 yards

If the temperature were down to just below freezing point, and the breeze were from "12 o'clock," then both of these would have to be deducted instead of added, and the result would stand as an increase of only 20 yards instead of 130.

The difference between $\frac{7}{8}$ and 1 is so small as scarcely to be worth reckoning, and it seems to us that for all practical purposes, XI., XII., I., and V., VI., VII., may be taken as equal, with II., IV., VIII., X., as half values.

In conclusion, we may say that so far as we have calculated them, the results obtained by means of Captain Mayne's formulæ come very close indeed to those marked out by much more cumbrous processes. They cannot be expected to be absolutely correct, because the ratio of atmospheric resistance is not exactly the same with different velocities; but, after all, variations of a few feet in ranges of hundreds of yards cannot be considered of any practical importance.

Captain Mayne alludes in his paper to the slight effect of $B-b$ on change of range, and shows that it may be dispensed with in the calculations from altitudes. A similar ground may, we think, be taken for dispensing with a calculation of the value of N, the difference between $\frac{M}{15}$ and $\frac{1,000}{15}$ being too small to have any material effect on change of range; and so, instead of $\frac{A}{N}$ we have $\frac{15.A}{1,000}$. In a similar way with the wind influence instead of $\frac{V}{4} \times \frac{R}{1,000}$ make it $\frac{15.V}{6} \times \frac{R}{1,000}$, and there is a uniformity throughout, in the use of this number 15, which seems to us to be an aid to memory, and would enable any one to mark out simple problems in the head, without having recourse to pencil and paper.

The revised formula would thus be

$$\frac{R}{1,000}\left\{(t-T) + \frac{15.A}{1,000} \pm f\,\frac{15.V}{6}\right\}$$

as the alteration in range due to atmospheric conditions.

Approximate Rules for Calculating the Combined Effects of Atmospheric Pressure, Temperature, and Wind on the Range of a Bullet.

(1) Reduce altitude of observer to corresponding temperature effect by dividing altitude by 60, and to this add any rise of temperature above, or from it deduct any fall of temperature below the normal temperature for which the rifle is sighted (say 60° F).

(2) To this apply $\pm f\,\frac{10.V}{4}$, where V is the velocity of the wind in miles per hour; $+$ for a rear wind.

(3) Multiply result by the range in yards, and divide by 1000. This gives the increase or decrease of range for any given graduation of the back-sight, according as the combined effect of (1) and (2) is $+$ or $-$ respectively.

Note 1.—*If the local barometer reading at the instant of firing is given instead of the altitude*, multiply (30 − barometer reading) by 15 to reduce it to corresponding temperature effect and then proceed as before.

Note 2.—Another way of finding the corresponding temperature effect to the altitude is to multiply the altitude by 15, and divide by 1000. Also the corresponding temperature effect of the wind may be put in the form of $\pm f\,\frac{15.V}{6}$. In this way we get a play on the number 15, which may be of assistance to the memory.

APPENDIX I

rds, of the trajectories of the Ma

ocity of 1,315 f.s., and when the Ther. is

ng most closely to the "culminating poin

Range, in Yards.	5	Yards. 650	700	750	800	850
100	**0·2**					
200	0·7					
300	1·3					
400	1·9					
500	2·5					
600	3·2					
700	3·91	6·167	0			
800	4·6	18·89	13·93	7·805	0	
900	5·44	32·42	28·76	23·92	17·48	9·632
1,000	6·27	46·60	44·28	40·80	35·80	29·39
1,100	7·14	**61·86**	60·64	58·59	55·11	50·23
1,200	8·07	77·50	**78·11**	77·59	75·71	72·46
1,300	9·04	94·12	96·34	**97·38**	97·21	95·63
1,400	10·08	111·9	115·7	118·5	120·0	**120·3**
1,500	11·15	130·3	136·0	140·5	144·0	146·1
1,600	12·31	150·2	157·7	164·1	169·5	173·8

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APPENDIX II.

Table of the Heights, in Feet, above the line of sight, at every 50 yards, of the trajectories of the Martini-Henry Rifle, at all ranges, for every 100 yards, from 100 to 1,600 yards.

For a Projectile with a blunt ogival head, a muzzle velocity of 1,315 f.s., and when the Ther. is at 62° F., Bar. 30 ins., and 1 cub. ft. of air weighs 534·22 grains.

NOTE.—The Height approximating most closely to the "culminating point" of each trajectory is printed in larger type.

Range, in Yards	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1,000	1,050	1,100	1,150	1,200	1,250	1,300	1,350	1,400	1,450	1,500	1,550	1,600
100	**0·25**	0																														
200	0·7473	**1·059**	0·8351	0																												
300	1·307	2·216	**2·634**	2·459	1·594	0																										
400	[illegible]	3·445	4·544	**5·071**	[illegible]	4·124	2·135	0																								
500	2·530	4·743	6·566	7·830	**8·513**	8·484	[illegible]	[illegible]	3·570	0																						
600	[illegible]	6·151	8·750	10·81	[illegible]	13·20	**13·25**	12·61	[illegible]	[illegible]	4·782	0																				
700	[illegible]	7·608	11·02	13·92	[illegible]	18·10	[illegible]	**19·41**	[illegible]	17·32	14·69	11·00	6·167	0																		
800	4·657	9·143	13·41	17·18	[illegible]	[illegible]	[illegible]	26·56	**27·02**	[illegible]	25·09	[illegible]	18·89	13·93	7·805	0																
900	5·446	10·77	15·94	20·65	25·01	28·72	[illegible]	34·16	[illegible]	**36·43**	36·16	34·85	[illegible]	28·76	23·92	17·48	9·632	0														
1,000	6·272	12·48	[illegible]	24·28	[illegible]	34·45	39·28	42·12	[illegible]	[illegible]	**47·76**	47·72	46·60	44·28	40·80	35·80	[illegible]	21·27	11·63	0												
1,100	7·144	14·29	21·39	28·09	34·61	40·50	[illegible]	[illegible]	54·44	[illegible]	[illegible]	61·31	**61·86**	[illegible]	58·59	55·11	50·23	43·71	[illegible]	25·71	13·96	0										
1,200	8·072	16·21	24·39	32·18	[illegible]	46·95	54·59	59·47	64·71	[illegible]	73·05	75·80	77·50	**78·11**	77·59	75·71	72·46	67·66	[illegible]	53·14	43·20	31·11	16·35	0								
1,300	9·042	18·21	27·51	36·45	45·36	53·67	[illegible]	68·82	[illegible]	[illegible]	86·66	[illegible]	94·12	96·34	**97·38**	97·21	[illegible]	92·60	88·08	81·74	73·67	63·52	50·86	36·54	19·01	0						
1,400	10·08	20·34	30·82	40·98	51·19	60·82	[illegible]	78·75	86·76	94·30	101·1	[illegible]	[illegible]	115·7	118·5	120·0	**120·3**	119·2	[illegible]	112·1	106·1	98·06	87·56	75·41	60·19	43·42	23·40	0				
1,500	11·15	22·57	34·29	45·71	57·31	68·31	80·76	[illegible]	98·65	107·7	116·2	123·7	130·3	136·0	140·5	144·0	146·1	**146·9**	146·3	144·0	140·1	134·2	126·0	116·1	103·2	88·82	71·25	50·46	27·20	0		
1,600	12·31	[illegible]	38·00	50·79	63·84	76·33	[illegible]	100·2	111·4	[illegible]	132·4	141·7	150·2	157·7	164·1	169·5	173·8	176·7	**178·1**	178·0	176·4	172·8	167·1	[illegible]	149·4	137·4	122·6	104·5	84·03	59·71	31·19	0

s, distances in mètres.

130	140	150	160	170	180	190	200	210
6	6	5	4	3	3	2	2	1
6	6	6	4	3	4	2	2	1
8	7	4	3					
8	7	4	3					
2	2	2	1					
2	2	2	1					
4	3	2	2					
5	3	2	2					

1	·	1				1		
3	2	1	1	3	·	1	2	1
6	4	3	4	4	3	4	3	1
1	1	1						
3	3	3						
1								
1								
2	·	·	·	·	1	·	·	2
3	1	·	·	·	3	1	2	4

APPENDIX III.

TABLE "A."

SERIES OBTAINED WITH ONE SIGHT AGAINST MEN STANDING.

The men fired lying down with their rifles supported on a rest. Targets 20 mètres wide, 1·80 mètres high.

Number of hits excluding ricochets.

Targets in front of nucleus, distances in mètres (200–110)

Back-sight adjusted for	No. of rounds	Targets representing	200	190	180	170	160	150	140	130	120	110
400 m.	100	Company in line	4	5	5	7	9	9	10	12	14	[illegible]
		" column	5	6	7	9	11	10	12	14	11	24
500 m.	100	" line							3	4	[illegible]	6
		" column							4	6	7	[illegible]
600 m.	100	" line								1	4	4
		" column								1	4	[illegible]
700 m.	100	" line										
		" column										
800 m.	100	" line										3
		" column										5
900 m.	100	" line									1	1
		" column									1	2
1000 m.	100	" line									1	3
		" column								1	[illegible]	[illegible]
1100 m.	100	" line										
		" column										
1200 m.	100	" line										
		" column										
1300 m.	100	" line										
		" column										
1400 m.	100	" line										1
		" column										1

Targets in front of nucleus, distances in mètres (100–10), and nucleus or mean centre of impact

Back-sight / Targets	100	90	80	70	60	50	40	30	20	10	Nucleus or mean centre of impact
400 m. line	18	21	26	30	41	5[illegible]	60	64	40	68	71
400 m. column	24	1	44	[illegible]	[illegible]	66	74	73	71	77	77
500 m. line	7	1	11	25	30	[illegible]	8	41	51	[illegible]	64
500 m. column	15	25	40	[illegible]	50	15	1	[illegible]	64	71	[illegible]
600 m. line	4	11	17	21	25	2	[illegible]	[illegible]	18	4	52
600 m. column	26	22	21	25	[illegible]	15	[illegible]	63	[illegible]	[illegible]	62
700 m. line	[illegible]	4	[illegible]		14	17	[illegible]	[illegible]	20	21	[illegible]
700 m. column	[illegible]		11	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	[illegible]
800 m. line	3	1	4	[illegible]	1	1	[illegible]	[illegible]	21	21	41
800 m. column	[illegible]	[illegible]	11	11	11	[illegible]	[illegible]	[illegible]	[illegible]	10	12
900 m. line	[illegible]				1	[illegible]	10	[illegible]	14	[illegible]	41
900 m. column	[illegible]	[illegible]	4	6	[illegible]	16	25	44	8	42	42
1000 m. line	[illegible]	[illegible]	4	[illegible]	4	15	18	14	1	[illegible]	27
1000 m. column	[illegible]	1	[illegible]	8	[illegible]	21	26	[illegible]	25	28	32
1100 m. line	1	3	1	1	[illegible]	11	13	[illegible]	7	17	18
1100 m. column	[illegible]		8	11	[illegible]	[illegible]	14	14	[illegible]	24	29
1200 m. line	2			[illegible]	[illegible]	2	[illegible]	12	13	15	2
1200 m. column			[illegible]		[illegible]	11	[illegible]	4	1	1	[illegible]
1300 m. line	[illegible]	[illegible]	2	1	[illegible]	[illegible]	6	10	8	8	21
1300 m. column	[illegible]	1		[illegible]	11	17	8	18	12	19	22
1400 m. line			[illegible]	2	4	4	2	[illegible]	8	10	11
1400 m. column	[illegible]		[illegible]	8	[illegible]	6	[illegible]	11	21	26	22

Targets in rear of nucleus, distances in mètres (10–100)

Back-sight / Targets	10	20	30	40	50	60	70	80	90	100
400 m. line	41	61	57	36	20	21	16	9	8	4
400 m. column	68	66	57	37	31	22	17	12	11	[illegible]
500 m. line	58	[illegible]	44	37	27	17	13	14	13	14
500 m. column	50	50	47	29	40	23	16	15	10	17
600 m. line	51	47	34	31	24	24	16	11	[illegible]	3
600 m. column	64	42	42	37	20	25	16	11	[illegible]	1
700 m. line	28	23	32	26	20	[illegible]	13	6	[illegible]	1
700 m. column	1	9	11	2	10	18	15	10	7	6
800 m. line	7	2	25	[illegible]	11	8	5	3	1	2
800 m. column	41	30	30	21	17	1	6	4	[illegible]	[illegible]
900 m. line	28	23	22	11	13	7	5	6	5	3
900 m. column	6	20	25	25	14	11	7	7	[illegible]	4
1000 m. line	36	13	5	7	9	10	3	1		
1000 m. column	41	17	11	18	16	11	4	1		
1100 m. line	17	14	12	1	11	5	2		2	1
1100 m. column	60	[illegible]	25	2	15	6	3	2	2	1
1200 m. line	14	10	6	7	2		1	2	[illegible]	1
1200 m. column	25	15	12	9	[illegible]	2	[illegible]	1	1	2
1300 m. line	7	10	8	6	3	2		1	1	
1300 m. column	17	11	12	11	5	2	2	4	1	
1400 m. line	16		17	9	4		1			
1400 m. column	24	25	25	13	4	1	1			

Targets in rear of nucleus, distances in mètres (110–210)

Back-sight / Targets	110	120	130	140	150	160	170	180	190	200	210
400 m. line	5	5	6	6	5	4	[illegible]	[illegible]	2	2	1
400 m. column	7	7	6	6	[illegible]	[illegible]	[illegible]	4	2	2	1
500 m. line	14	13	8	7	4	1					
500 m. column	17	13	8	7	4	3					
600 m. line	[illegible]	1	2	2	2	1					
600 m. column	2	2	2	2	2	1					
700 m. line	5	4	4	3	2	2					
700 m. column	[illegible]	6	[illegible]	3	2	2					
800 m. line	1	1									
800 m. column	1	1									
900 m. line	1	2									
900 m. column	2	2									
1000 m. line											
1000 m. column											
1100 m. line											
1100 m. column											
1200 m. line	1										
1200 m. column	1										
1300 m. line											
1300 m. column											
1400 m. line											
1400 m. column											

TABLE "B."

SERIES OBTAINED WITH ONE SIGHT AGAINST MEN LYING DOWN.

Targets [illegible]0 mètres wide, 0·45 mètre high.

Targets in front of nucleus, distances in mètres (200–110)

Back-sight adjusted for	No. of rounds	Targets representing	200	190	180	170	160	150	140	130	120	110
400 m.	200	Company in line							1			4
		" column							1	1	[illegible]	7
500 m.	200	" line							1	2	2	1
		" column							1	2	2	1
600 m.	200	" line										2
		" column										4
700 m.	200	" line										
		" column										
800 m.	200	" line						1		3	2	
		" column		1	1		1	1	3	[illegible]	2	3
900 m.	200	" line										
		" column										
1000 m.	200	" line										
		" column										
1100 m.	200	" line										
		" column										
1200 m.	200	" line										
		" column										
1300 m.	200	" line										
		" column										
1400 m.	200	" line										
		" column										

Targets in front of nucleus, distances in mètres (100–10), and nucleus or mean centre of impact

Back-sight / Targets	100	90	80	70	60	50	40	30	20	10	Nucleus or mean centre of impact
400 m. line	[illegible]	[illegible]	17	[illegible]	2	24	4	[illegible]	[illegible]	3	47
400 m. column	26	29	[illegible]	44	[illegible]	66	[illegible]	57	[illegible]	[illegible]	74
500 m. line				1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10	41
500 m. column			2	[illegible]	[illegible]	10	20	60	71	[illegible]	[illegible]
600 m. line	2	2	[illegible]	11	17	[illegible]	[illegible]	14	22	[illegible]	29
600 m. column	[illegible]	11	[illegible]	2	[illegible]	12	1	41	19	[illegible]	67
700 m. line			1	1	[illegible]	[illegible]	17	[illegible]	1	13	27
700 m. column		7	10	[illegible]	41	[illegible]	40	13	[illegible]	13	51
800 m. line	1	2	1	[illegible]	4	2	4	8	1	10	19
800 m. column	3	1	[illegible]	7		12	[illegible]	[illegible]	[illegible]	8	34
900 m. line	1		1		2	2	2	[illegible]	8	1	14
900 m. column	1	1	2	4	[illegible]	8	12	22	7	[illegible]	50
1000 m. line			1	2	4	[illegible]	4	5	11	8	8
1000 m. column			5	7	6	7	21	28	[illegible]	2	2
1100 m. line		1	2		[illegible]	1		[illegible]	6	13	15
1100 m. column	3	4	[illegible]	5	8	10	16	[illegible]	20	20	21
1200 m. line	—	3	1	[illegible]	1	3	5	[illegible]	6	7	10
1200 m. column		5	6	5	4	12	8	10	21	17	8
1300 m. line		1	2	[illegible]	3	2	4	6	3	3	7
1300 m. column	1	[illegible]	[illegible]	12	8	6	12	14	7	13	17
1400 m. line			1	1	2	3	5	8	7	7	8
1400 m. column			2	7	9	10	20	19	11	16	16

Targets in rear of nucleus, distances in mètres (10–100)

Back-sight / Targets	10	20	30	40	50	60	70	80	90	100
400 m. line	12	11	[illegible]	13	12	[illegible]	[illegible]	6	5	6
400 m. column	[illegible]	44	27	[illegible]	17	11	11	[illegible]	11	8
500 m. line	2	[illegible]	[illegible]	[illegible]	[illegible]	14	[illegible]	11	11	[illegible]
500 m. column	[illegible]	[illegible]	45	[illegible]	[illegible]	4	21	[illegible]	[illegible]	8
600 m. line	23	[illegible]	[illegible]	7	[illegible]	5	4	3	5	2
600 m. column	[illegible]	[illegible]	18	[illegible]	13	11	11	10	9	1
700 m. line	22	12	7	[illegible]	[illegible]	2	1	2		
700 m. column	40	[illegible]	[illegible]	[illegible]	[illegible]	6	4	2		1
800 m. line	7	10	10	1	1	[illegible]	3	1		
800 m. column	8	[illegible]	16	[illegible]	11	8	7	7	[illegible]	1
900 m. line	11	[illegible]	14	1	9	6	2	1		2
900 m. column	[illegible]	[illegible]	25	[illegible]	11	11	6	1	2	2
1000 m. line	4	[illegible]	7	8	1	3	7	3		1
1000 m. column		11	22	21	14	10	11	1	2	3
1100 m. line	6	5	8	8	1	2	1	2		1
1100 m. column	18	[illegible]	[illegible]	11	9	5	4	3		2
1200 m. line	1	[illegible]	2	[illegible]	1	1				
1200 m. column	12	14	5	[illegible]	[illegible]	1				
1300 m. line	[illegible]	2	5	1	[illegible]	1				
1300 m. column	12	9	11	9	8	3	3	1		
1400 m. line	3	[illegible]	6	2	2		2		1	
1400 m. column	7	9	12	2	1	4	4		1	2

Targets in rear of nucleus, distances in mètres (110–210)

Back-sight / Targets	110	120	130	140	150	160	170	180	190	200	210
400 m. line	[illegible]		1		1				1		
400 m. column	4	1									
500 m. line	10	[illegible]	3	2	1	1	3		1	2	1
500 m. column	10	1	6	4	1	4	4	3	4	3	1
600 m. line	2		1	1	1						
600 m. column	2	2	3	3	[illegible]						
700 m. line	1		1								
700 m. column	1		1								
800 m. line	1	1	2					1			2
800 m. column	[illegible]	1	1	1				3	1	2	4
900 m. line											
900 m. column											
1000 m. line	1										
1000 m. column	2										
1100 m. line											
1100 m. column											
1200 m. line											
1200 m. column											
1300 m. line											
1300 m. column											
1400 m. line											
1400 m. column											

Back sights adjusted for	No. of rounds fired with each sight	250	260	270	280	290	300	320
400 and 500 m.	100	9	10	12	14	15	18	:
500 and 600 m.	100							1
600 and 700 m.	100							34
700 and 800 m.	100							37
800 and 900 m.	200							5
		800	810	820	830	840	850	270
900 and 1000 m.	200	2	1	3	5	8	10	
1000 and 1100 m.	200							
1100 and 1200 m.	200							1
1200 and 1300 m.	300							13
1300 and 1400 m.	300							33

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Back sights adjusted for	No. of rounds fired with each sight	250	260	270	280	290	300	72
400 and 500 m.	200							4
500 and 600 m.	200						2	4
600 and 700 m.	200							33
700 and 800 m.	300							34
800 and 900 m.	300							6
		800	810	820	830	840	850	12
900 and 1000 m.	300	4	5	2	5	12	19	
1000 and 1100 m.	300							
1100 and 1200 m.	300							1

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APPENDIX IV.

TABLE "C."

SERIES OBTAINED WITH TWO SIGHTS AGAINST A LINE STANDING.

Distances of the targets from the men firing in mètres. — Number of hits excluding ricochets.

Back-sights adjusted for	No. of rounds fired with each sight	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400
400 and 500 m.	100	9	10	12	14	15	18	24	26	[illegible]	41	53	65	68	74	74	78
500 and 600 m.	100												3	4	4	6	7
600 and 700 m.	100																
700 and 800 m.	100																
800 and 900 m.	50																

Back-sights adjusted for	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600
400 and 500 m.	70	75	82	64	51	67	57	60	61	68	63	55	50	43	42	41	[illegible]	16	15	[illegible]
500 and 600 m.	9	18	25	30	[illegible]	[illegible]	42	45	60	68	64	67	65	60	52	52	12	62	62	66
600 and 700 m.							1	1	4	4	11	17	21	23	25	[illegible]	10	18	19	55
700 and 800 m.																				1
800 and 900 m.																				

Back-sights adjusted for	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800
400 and 500 m.	15	14	10	8	4	4														
500 and 600 m.	60	60	[illegible]	18	28	27	10	11	6	3		1	2	2	2	2				
600 and 700 m.	45	55	41	15	[illegible]	43	12	37	34	38	28	84	4	28	31	18	13	6	3	4
700 and 800 m.	4	[illegible]	7	14	[illegible]	[illegible]	[illegible]	26	32	[illegible]	[illegible]	[illegible]	4	38	42	[illegible]	32	40	27	35
800 and 900 m.		3	[illegible]	2	1	1		5	5	5	4	[illegible]		8	10	15	23	36	50	58

Back-sights adjusted for	810	820	830	840	850	860	870	880	890	900	910	920	930	940	950	960	970	980	990	1000
400 and 500 m.																				
500 and 600 m.																				
600 and 700 m.	5	4	4	3	2	2														
700 and 800 m.	32	33	27	[illegible]	16	[illegible]	5	3	1	2	1	1								
800 and 900 m.	51	47	[illegible]	[illegible]	[illegible]	32	46	[illegible]	57	56	[illegible]	51	43	23	24	21	8	4	4	

Distances of the targets from the men firing in mètres. — Number of hits excluding ricochets.

Back-sights adjusted for	No. of rounds fired with each sight	800	810	820	830	840	850	860	870	880	890	900	910	920	930	940	950
900 and 1000 m.	200	2	1	3	5	8	10	18	42	49	50	50	50	48	[illegible]	24	[illegible]
1000 and 1100 m.	200														[illegible]	8	[illegible]
1100 and 1200 m.	200																
1200 and 1300 m.	300																
1300 and 1400 m.	300																

Back-sights adjusted for	960	970	980	990	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090	1100	1110	1120	1130	1140	1150
900 and 1000 m.	28	16	26	40	47	35	28	28	27	25	21	18	14	14		2	[illegible]	1		
1000 and 1100 m.	[illegible]	8	22	36	40	[illegible]	[illegible]	41	42	[illegible]	[illegible]	[illegible]	[illegible]	17	41	[illegible]	[illegible]	21	31	[illegible]
1100 and 1200 m.					[illegible]	4	6	3	5	8	11	18	25	31	48	[illegible]	26	29	[illegible]	31
1200 and 1300 m.									1	2	1		1	[illegible]	[illegible]	[illegible]	1	[illegible]	11	15
1300 and 1400 m.																				

Back-sights adjusted for	1160	1170	1180	1190	1200	1210	1220	1230	1240	1250	1260	1270	1280	1290	1300	1310	1320	1330	1340	1350
900 and 1000 m.																				
1000 and 1100 m.	[illegible]	9	[illegible]	4	[illegible]	3														
1100 and 1200 m.	[illegible]	[illegible]	41	[illegible]	[illegible]	[illegible]	12	16	[illegible]	10	4	1		1	1	1				
1200 and 1300 m.	14	21	[illegible]	[illegible]	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21	13	[illegible]	22	27	15	18	21	21	21
1300 and 1400 m.				14	18	13	15	18	[illegible]	[illegible]	17	33	[illegible]	[illegible]	46	44	34	35	28	19

Back-sights adjusted for	1360	1370	1380	1390	1400	1410	1420	1430	1440	1450	1460	1470	1480	1490	1500	1510	1520	1530	1540	1550
900 and 1000 m.																				
1000 and 1100 m.																				
1100 and 1200 m.																				
1200 and 1300 m.	[illegible]	[illegible]	[illegible]	[illegible]	35	26	26	10	10	5	8	6	5	2	1	2		2		1
1300 and 1400 m.	21	24	[illegible]	16	[illegible]	[illegible]	15	[illegible]	13	25	14	13	12	12	9	4	1	3	3	4

TABLE "D."

NUMBER OF MEN'S BREADTHS (0·40) HIT ON A TARGET THE HEIGHT OF A MAN (1·80 M.), AND 20 M. (OR 50 MEN'S BREADTHS) WIDE.

(All hits on the same man's breadth counting as one hit.)

Distances of the targets from the firing points in mètres. — Number of men's breadths hit.

Back-sights adjusted for	No. of rounds fired with each sight.	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400
400 and 500 m.	200							26	26	30	31	35	38	[illegible]	41	43	42
500 and 600 m.	200						2	4	4	[illegible]	7	10	11	25	28	[illegible]	35
600 and 700 m.	200																
700 and 800 m.	300																
800 and 900 m.	400																

Back-sights adjusted for	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600
400 and 500 m.	45	44	43	44	44	45	44	43	42	41	[illegible]	36	35	34	29	28	21	25	24	21
500 and 600 m.	15	36	38	38	37	34	32	27	31	34	35	30	41	41	42	40	[illegible]	4	11	41
600 and 700 m.					[illegible]	2	3	5	1	18	23	[illegible]	28	[illegible]	[illegible]	31	[illegible]	[illegible]	[illegible]	31
700 and 800 m.																			2	4
800 and 900 m.																				

Back-sights adjusted for	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800
400 and 500 m.	17	11	10	[illegible]	7	5	8	6	6	7	5	4		3	3	2	1	1		
500 and 600 m.	48	[illegible]	41	21	[illegible]	[illegible]	[illegible]	14	11	11	9	1		3	5	4	3	2		
600 and 700 m.	[illegible]	4	4	[illegible]	1	[illegible]	[illegible]	[illegible]	11	[illegible]	45	43	[illegible]	25	[illegible]	21	11	8	4	2
700 and 800 m.	1	1	10	20	[illegible]	30	11	33	45	46	33	41	[illegible]	20	24	25	23	25	28	35
800 and 900 m.										2		[illegible]		12	[illegible]	[illegible]	26	32	40	[illegible]

Back-sights adjusted for	810	820	830	840	850	860	870	880	890	900	910	920	930	940	950	960	970	980	990	1000
400 and 500 m.																				
500 and 600 m.																				
600 and 700 m.	1	1	2	1	1															
700 and 800 m.	31	40	26	22	14	13	14	10	7	8	6	3	6	7	4	1				
800 and 900 m.	[illegible]	35	[illegible]	37	34	31	33	37	38	36	36	[illegible]	12	34	26	10	8	6	2	2

Distances of the targets from the firing points in mètres. — Number of men's breadths hit.

Back-sights adjusted for	No. of rounds fired with each sight.	800	810	820	830	840	850	860	870	880	890	900	910	920	930	940	950
900 and 1000 m.	400	4	5	2	5	12	[illegible]	22	21	26	31	32	34	32	43	33	30
1000 and 1100 m.	400												5	2	5	6	9
1100 and 1200 m.	400															1	1

Back-sights adjusted for	960	970	980	990	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090	1100	1110	1120	1130	1140	1150
900 and 1000 m.	26	29	27	33	34	35	29	28	28	22	14	11	8	7	6	5		1	1	1
1000 and 1100 m.	22	26	30	36	35	37	34	31	30	41	29	29	30	29	30	[illegible]	21	20	14	12
1100 and 1200 m.			4	7	1	5	6	11	14	20	23	26	31	31	31	[illegible]	[illegible]	[illegible]	18	[illegible]

Back-sights adjusted for	1160	1170	1180	1190	1200	1210	1220	1230	1240	1250	1260	1270	1280	1290	1300	1310	1320	1330	1340	1350
900 and 1000 m.																1				
1000 and 1100 m.	9	4	3	4	2															
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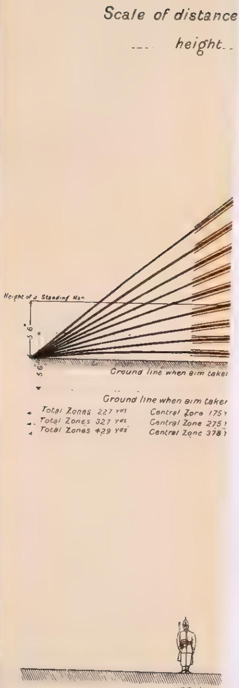

Scale of distance
height
Height of a Standing Man
5' 6"
5' 6"
Ground line when aim taken
Ground line when aim taken
Total Zones 227 yds
Central Zone 175
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Guide to Promotion, Corporal to Sergeant	2	6
Guide to Official Letter Writing, Orders, &c.	1	6
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Blotting Pads with Leather Corners ... ...each 1/6 and	2	6

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Ditto. ditto. 2nd quality, with Ordinary Pad, 12/0.

Reading Cases for Newspapers and Magazines.

See Library List of Prices on Page 33.

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The Royal Set of Officers' Mess Account Books (copyright) arranged by Qr.-Mr. D. WHITE, Manchester Regiment.

	s.	d.
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No. 6.—Daily Wine Account. Double Foolscap size, 26in. by 16in., Ruled, Printed, Paged and Bound in Leather	24	0
No. 7.—Mess Sergeants' Stock Book. Double Foolscap size, 26in. by 16in., Ruled, Printed, Paged and Bound in Leather	24	0
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No. 13.—Guest Book. Medium 4to. size, 21-in. by 9-in., Ruled, Printed and Bound in Leather	10	0
No. 14.—Caterers' Daily Account of Messing Stores Purchased	12	0
No. 15.—Caterers' Monthly Grocery Account Book	12	0
No. 16.—Whist Book	12	0

	250	500	1,000.
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Mess Debit Forms, size 4½in. by 7½in.	7 -	10 -	15 -
Mess Bills of Fare, size 4½in. by 7½in.	5 -	10 -	15 -

		s.	d.
Mess Washing Books containing duplicate forms with special washing lists,	each	2	-
Cases for Names of President, Vice-President, &c., in Whole Red Leather, to stand on mantle-shelf or to hang up, Gilt finished	each	8	0
Guard Books for Invoices, size 12in. by 9½in., ½-bound	each	5	0
Guard Books for Receipts	each	5	0
Best Rubber Stamps, for Papers and Linen	each, from	3	6

RECREATION ROOMS AND LIBRARIES.

Books strongly recommended for Library Tables.	s.	d.
Manual and Firing Exercise, Bound in Cloth	0	9
Hints to Young Soldiers, Bound in Cloth	0	9
Guide to Civil Employment, Bound in Cloth	0	9
On Outpost Duty, Bound in Cloth ... -	0	9
On Guard, Bound in Cloth	0	9
Catechism on Field Training	2	0
Physical Training, Fully Illustrated, Bound in Cloth...	1	0
Physical Drill, Fully Illustrated, Bound in Cloth	1	0
Guides and Markers' Duties	2	0
Guide to Promotion, Lance-Corporal to Corporal	2	6
Guide to Promotion, Corporal to Sergeant	2	6
Infantry Fire Tactics	6	0
Company, Battalion and Brigade Drill made Easy	5	0
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